Computer Systems Tutorial

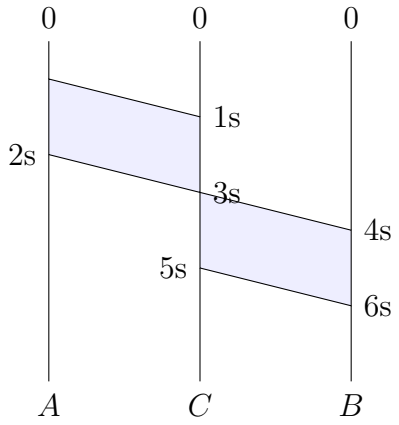
December 1^{st} 2023

1 Preliminaries

Let's recall how store-and-forward packet switching works. Suppose we have the following configuration and want to send a packet of size 40 KBytes from A to B and C is the intermediate router.

$$A \longrightarrow C \longrightarrow B$$

If the switching is store-and-forward, then C should receive the whole packet before it can start sending it to B. Suppose the data rate of channels $A \to C$ and $C \to B$ are the same and equal to 20 KBytes per second (160 Kbits/sec) and the propagation delay of both channels is 1 second. Then the following sequence diagram describes the time when the packet finally arrives at B.



Because the bandwidth of the channel is 20 KBytes/sec, A needs 2 seconds to put all the data onto the wire and because the propagation delay is 1 second, the first bit arrives at C at 1s and the last bit at 3s. Similarly for the trip between C and B.

Recall that **throughput** is the actual amount of data that is transferred per time unit (the bandwidth is the maximal amount of data that can be transferred). Because the amount of data we sent above is more than the channel can get per second, we get that the throughput is equal to the bandwidth.

2 Exercises

Exercise 1 Suppose the path from A to B has a single switch S in between: $A \longrightarrow S \longrightarrow B$. Each link has a propagation delay of 60 µsec and a bandwidth of 2 bytes/µsec. How long would it take to send two back-to-back 300-byte packets from A to B?

Exercise 2 We know that RDT3.0 is correct, but it suffers greatly in terms of performance due to being a Stop-and-Wait protocol. Let's assume that we have a 100 Mbps link between two devices and 40ms propagation delay, what will be the **throughput** on this link for a packet size of 4 KBytes when using RDT 3.0 protocol? Before we can send the next packet we need to wait for a packet with an acknowledgement and assume that this packet's size is also 4 KBytes and also assume that no packet is corrupted or lost.

Exercise 3 For each IP network prefix given (with length), identify which of the subsequent IP addresses are part of the same subnet.

a **10.0.130.0/23:** 10.0.130.23, 10.0.129.1, 10.0.131.12, 10.0.132.7

b **10.0.132.0/22:** 10.0.130.23, 10.0.135.1, 10.0.134.12, 10.0.136.7

c **10.0.64.0/18:** 10.0.65.13, 10.0.32.4, 10.0.127.3, 10.0.128.4

Exercise 4 By using Wireshark trace the TCP packets that arise when communicating with a web server over HTTP. In particular, have a look at the initial handshake and sequence and ACK numbers.