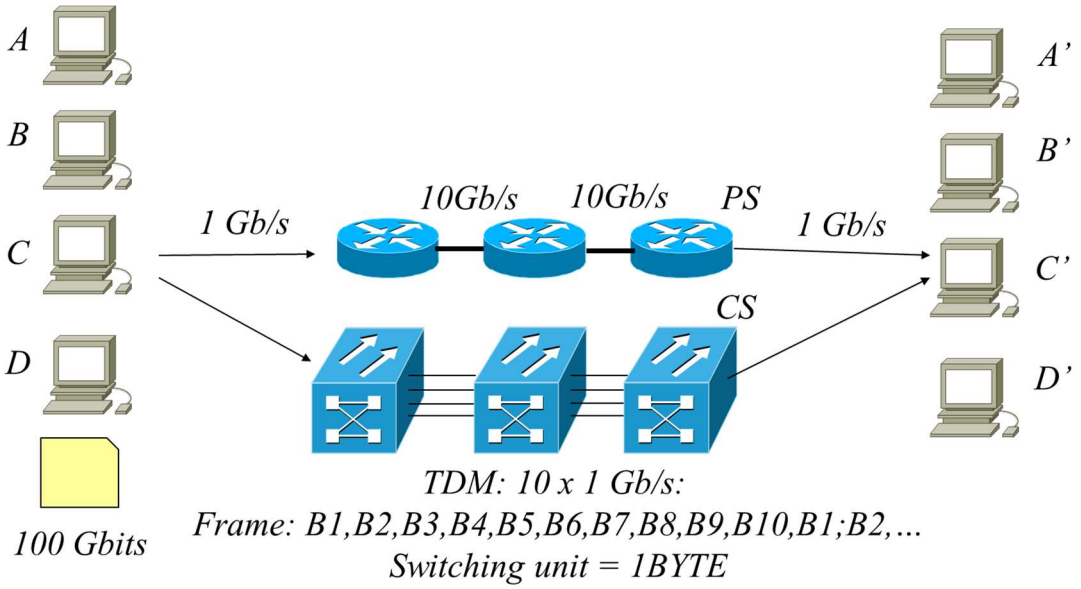
Exercise Switching Techniques

We want to compare the performance of two switching technologies in as-fair-as-possible conditions. To this end, we build the network set up of the Figure.
Each of the end-systems A,B,C,D needs to send concurrently a 100Gbit file to end-systems A',B',C',D' respectively. For this purpose, they have two 1Gb/s line cards (connected to point-to-point dedicated links), each of them interfacing a different type of network technology: a Packet Switching network (in the middle) and a Circuit Switching network (bottom). For the sake of simplicity, the Figure only shows the links of end systems C and C'.



We'd like to make a simple comparison of the two technologies by analyzing the file transfer time when all use the same technology at the same time.

Assumptions:

- There is no other traffic in the network.
- BER=0 (bit error rate) in the links.
- Propagation delay=0 (remember that normally it is 5microsec/Km in a fiber).
- No protocol overhead at all. Only file bytes are sent in all cases, not headers.
- Switching time=0 in switches (remember that normally this time is a few microsecs). That is, in this exercise we only consider queuing delay (when there is such delay) and transmission delay.
- For PS:
    - Assume packets of size 10000 bits, sent back-to-back (i.e. no gap between them), infinite buffers, and packets are served in round-robin fashion. This means that if packets A,B,C,D arrive simultaneously at the input ports of a router destined to the same output port, then the router would write the packets to the output buffer in this order: A,B,C,D,A,B,C,..

- For CS:
    - Assume that the switches are connected by a 10Gb/s link, which is channelised into 10 x 1Gb/s-TDM channels. The switching unit is 1 BYTE. In other words, the bytes from the ten channels are sent like this: B1,B2,B3,B4,B5,B6,B7,B8,B9,B10,B1,B2,B3,… and there isn't any additional framing overhead (no control bytes, OAM bytes, frame alignment sequence, checksum, etc).

Questions:

1) **In the worst case** for the end system D (i.e. D is always the last to be served in the round robin, etc), how long would it take each technology to transfer the **whole file for D**?
2) Which technology would deliver the first byte of the file first? Give an estimation of latency for that byte, in the worst case for D, for each technology.
3) Now imagine that instead of a file, the data corresponds to a live videoconference. Do you think that the latency estimated in question 2 is low enough in the two technologies? Which one is the best?
4) Now imagine there are N=20 end-systems on each side of the picture sending one file each. How many simultaneous file transfers can be supported by the CS network?
5) Same assumption as 4). How many simultaneous file transfers could be supported by the PS network?