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Why is packet switching called a store-and-forward approach?
The entire packet must first arrive at the router before it can be transmitted to the next link. While forwarding the packet, at each hop the packet is stored first so that if needed, it can be discarded at any point.

Suppose users share a 10Mbps link, and each user transmits continuously at 2Mbps when transmitting. Each user transmits only 40% of the time. 1) How many users can be supported by this link when using circuit switching? 2) What is the utilization of the link?
1) 10Mbps / 2Mbps = 5 users can be supported.
2) The utilization of this link is 20% per user due to the maximum of 5 supported users.

Under the same setting as the problem above. Assuming that packet-switching is used with 8 users. (1) What is the probability that only a (selected) user is transmitting, and the rest are not transmitting? (2) What is the probability that more than 5 users are transmitting at the same time? You can show the equations without the numerical results. (4 pts/each)
1) The probability that a selected user is transmitting and the rest are not is $p * (1-p)^{N_{PS}-1}$
2) The probability that more than 5 users are transmitting at the same time is
   $\Sigma_{i=6,8}$ choose(8, i) * $p^i(1-p)8^{-i}$

Name at least one difference between DSL and cable networks? (2 pts)
Cable homes share access network to cable headend. DSL has dedicated access to central office.

What are the four delay components in this end-to-end transmission? (4 pts)
- Processing delay: The time it takes for a a router to process the packet header.
- Queueing delay: How long a job waits to be executed within a queue
- Transmission delay: time it takes to put packet onto link. Depends on length of packet/bandwidth.
- Propagation delay: Time the first bit takes to travel from the sender to receiver end of the link.

Given the network below, where L_1,L_2,L_3 are the length of the links in meters, R_1,R_2,R_3 are the transmission rate in bits/second, and the propagation speed is P meters/second. Sender S is sending packets of size K bits to the receiver R. (1) If we do not consider the propagation delay, what would be the end-to-end delay between S and R? (2) What is the throughput between S and R? (3) What can we do to reduce the end-to-end delay? (4) What can we do to increase the throughput between S and R? (2 pts/each)
1) The end-to-end delay between S and R is (L1/R1) + (L2/R2) + (L3 / R3).
2) End-to-end throughput between S and R is min(R1, R2, R3)
3) End-to-end delay can be reduced by addressing network congestion and bottlenecks.
4) Addressing network bottlenecks minimizes network latency which would increase throughput between S and R.

(Transmission/propagation delay) Consider a highway that has a tollbooth every 20 km, and cars travel on the highway at a rate of 100 km/hour. Assume that 8 cars travel together as a

caravan and travel in a fixed order. Suppose each tollbooth services a car at a rate of 5 minutes per car, and no other cars except these 8 cars are on the highway. Finally, suppose that whenever the first car of the caravan arrives at a tollbooth, it will not be processed by the toll booth but wait at the entrance until all other cars arrive and line up behind it.

(i) What is the total time required for a whole caravan to travel from the entrance of the first tollbooth to the entrance of the next tollbooth (all cars should be lined up.) (2 pts)

It takes 40 minutes for the whole caravan to get through a tollbooth. At 100km/h, it takes 12 minutes to get from one tollbooth to another. 52 minutes for the whole caravan to travel from the entrance of the first tollbooth to the entrance of the next.

(**ii) Why in the example we emphasize that all the cars have to line up before the first car can be processed at the toll booth? (2 pts)**

In the store-and-forward model for packet switching, the entire packet must first arrive at the router before it can be transmitted to the next link.

(iii) What is the meaning of the 5 minutes processing time at the toll booth? (Note: this is asking you which type of the delay it is). (2 pts)

The five minutes processing time is a processes delay.

(iv) According to the calculation in (i), will the first car arrive the next tollbooth before the fourth car's departure from the first tollbooth? Provide your evaluation here (only provide the Yes or No answer will not earn you the credit). (2 pts)

Yes and it will wait until the rest of the cars arrive and line up behind it to be processed and move forward.

We use traceroute (Linux/Mac) or tracert (Windows) to find a path from your de- vice/ machine to a destination and also measure the end-to-end delays. Assume that there are two routers on the path between your machine and the destination, how many delay measurement (packets) will be sent out from your device? (2 pts)

Six delay packets will be sent out from the device.

What are the fundamental causes of packet loss? (2 pts)

The queue is close to full or full, the packet will be dropped. Excessive hops and link congestion will also result in delays or packet loss.