CS 168 Spring 2020 | Introduction to the Internet Sylvia Ratnasamy | Discussion 1: Packets in Flight

1 True or False

(1) On a fast cross-continental link ($\approx$ 100Gbps), *propagation delay* usually dominates *end-to-end packet delay*.

(2) On the same cross-continental link ($\approx$ 100Gbps), when transferring a 100GB file, *propagation delay* still dominates end-to-end file delivery.

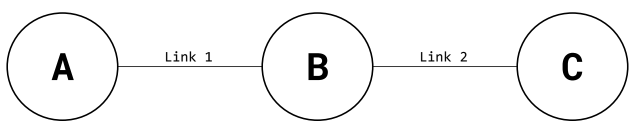
(3) On-demand circuit-switching is adopted by the Internet.

(4) The aggregate (i.e., sum) of peaks is usually much larger than peak of aggregates in terms of bandwidth usage.

(5) Bursty traffic (i.e., when packet arrivals are not evenly spaced in time) always leads to queuing delays.

2 End-to-End Delay

Consider the diagram below. Link 1 has length L_1 m (where m stands for meters) and allows packets to be propagated at speed $S_1 \frac{\text{m}}{\text{sec}}$, while Link 2 has length L_2 m but it only allows packets to be propagated at speed $S_2 \frac{\text{m}}{\text{sec}}$ (because two links are made of different materials). Link 1 has transmission rate $T_1 \frac{\text{bits}}{\text{sec}}$ and Link 2 has transmission rate $T_2 \frac{\text{bits}}{\text{sec}}$.



Assuming nodes can send and receive bits at full rate and ignoring processing delay, consider the following scenarios:

(1) How long would it take to send a packet of 500 Bytes from Node A to Node B given $T_1 = 10000$, $L_1 = 100000$, and $S_1 = 2.5 \cdot 10^8$?

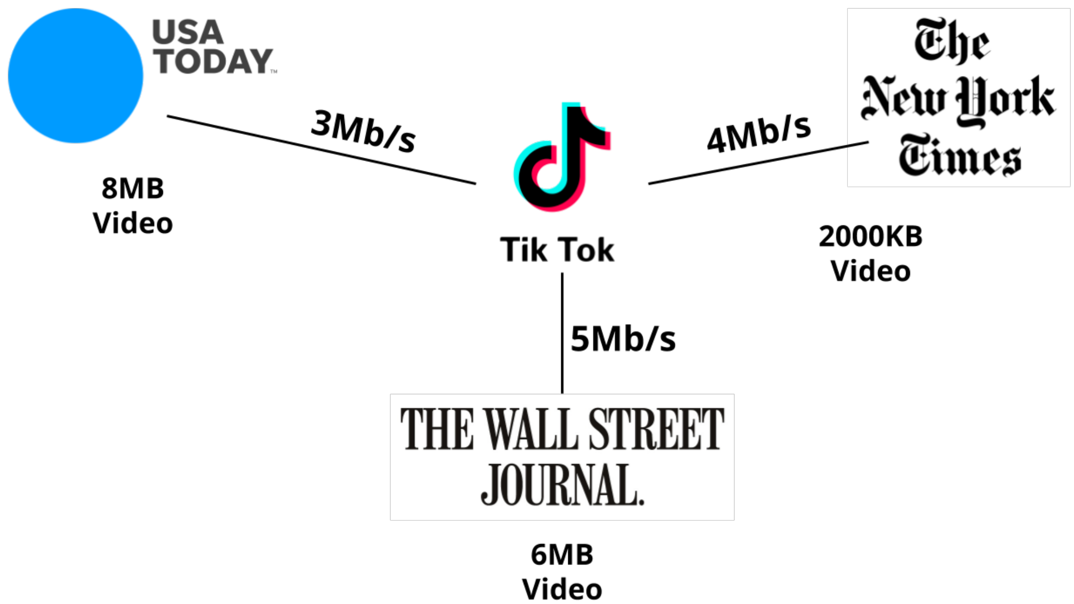
(2) Compute RTT (round trip time) for a packet of B Bytes sent from Node A to Node C (packet gets transmitted back from Node C immediately after Node C receives it).

(3) At time 0, Node A sends packet P_1 with D_1 Bytes and then it sends another packet P_2 with D_2 Bytes immediately after it pushes all bits of P_1 onto Link 1. When will Node C receive the last bit of P_2?

(4) Find the variable relations that need to be satisfied in order to have no queuing delays for part (c).

3 First one to TikTok wins!

As you may know, the Washington Post has a pretty spicy TikTok account. Execs at the New York Times, the Wall Street Journal, and USA Today have also noticed the Post's success and want to promote their brand on the platform. Each organization has filmed a take on the 9 to 5 challenge video to use as their first upload to TikTok. They are all waiting for the perfect moment to post.



Upon seeing the perfect opportunity, all three organizations begin uploading their video at almost the same time (within 3-seconds of each other). If we assume that propagation time is negligible, which news organization will be the first to publish their video (and ultimately become #1 trending on TikTok)?

4 Statistical Multi-What?

Consider three flows (F_1, F_2, F_3) sending packets over a single link. The sending pattern of each flow is described by how many packets it sends within each one-second interval; the table below shows these numbers for the first ten intervals. A perfectly smooth (i.e., non-bursty) flow would send the same number of packets in each interval, but our three flows are very bursty, with highly varying numbers of packets in each interval:

Time (s)	1	2	3	4	5	6	7	8	9	10
F_1	1	8	3	15	2	1	1	34	3	4
F_2	6	2	5	5	7	40	21	3	34	5
F_3	45	34	15	5	7	9	21	5	3	34

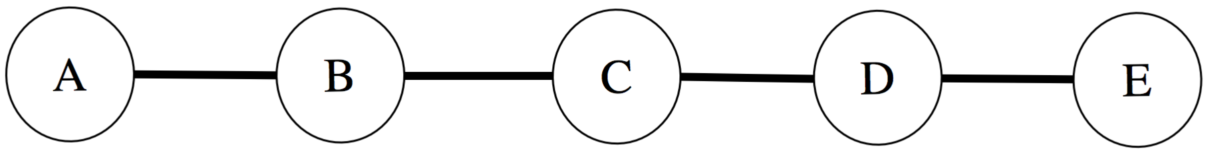
(Questions on next page)

(1) What is the peak rate of F_1? F_2? F_3? What is the sum of the peak rates?

(2) Now consider all packets to be in the same aggregate flow. What is the peak rate of this aggregate flow?

(3) Which is higher - the sum of the peaks, or the peak of the aggregate?

5 Plenty of Packets



Let's suppose we have three packets (P_1, P_2, P_3) of size x, y, z bytes respectively. We want to send packet P_1 from A to C and packets P_2 and P_3 from C to E.

Use the following values for all calculations:

x	2000 bytes
y	500 bytes
z	1000 bytes
L_{AB}	100 km
L_{BC}	50 km
L_{CD}	75 km
L_{DE}	100 km
S_{AB}	$1.5 * 10^8 \frac{m}{s}$
S_{BC}	$2 * 10^8 \frac{m}{s}$
S_{CD}	$2 * 10^8 \frac{m}{s}$
S_{DE}	$1.75 * 10^8$
T_{AB}	$5000 \frac{b}{s}$
T_{BC}	$8000 \frac{b}{s}$
T_{CD}	$10000 \frac{b}{s}$
T_{DE}	$7000 \frac{b}{s}$

(1) Will P_1 reach its destination first or will P_2 and P_3 arrive before?

(2) How small would P_1 have to be for it to take longer to send the other two packets?