Telematic Applications 2019. Continuous assesment.
Fecha: 29/10/2016

Given name:________________________________
Surname(s):_______________________________

Instructions
Available time : 90 min
Explain **clearly but briefly** every step you make in the exam considering that a correct answer with no explanation may not necessarily be considered valid. Answer the exam using exam paper sheets. Explicitly describe any supposition you make, however, unless contradicted by the question, you can assume the following:

- the sender always delivers every segment of the window or those the question describes (using segments that are MSS long) before receiving the ACK that acknowledges the first segment delivered in that window
- every segment is acknoledged individually

Preliminary solution The solution of the exam is given but not thoroughly verified. Please let us know any discrepancy.

Problem Juan has a brand-new optical fiber connection with a new provider. That new connection provides a bandwidth of 200Mbps and propagation delay of 3ms ($t_p = 3ms$) with the server of an online gaming platform Juan is willing to use. The online gaming platform has several Internet connection requirements that should be satisfied in order to play and you should evaluate if Juan will or won't be able to with his new connection. Considering the TCP stack is configured to use a slow start threshold of 64 segments, WIN for both endpoints is set to 200 segments, and the MTU of the connection is 1500 bytes, answer the following questions:

1. (0.5 puntos) How big would be the congestion window (`cwnd`) and the effective window (V_{ef}) if the connection is open for a very very long time and there is no congestion? why?

   sol: Infinite. The congestion window is a math param that increases using slow start ($cwnd \leq ssthresh$) or congestion avoidance ($cwnd > ssthresh$) upon ACK reception.

   sol: The effective window is another math param that combines flow control and congestion control through the corresponding windows (WIN, and $cwnd$). It's expression is $V_{ef} = min(cwnd, WIN)$. We know $cwnd$ may be quite big (up to infinite), but from the problem statement we know WIN is limited to $WIN = 200$ segments. So, the maximum value V_{ef} may reach, would not be over WIN, so 200.

2. Calculate the continuous delivery window[1][2] (V_{ec}). V_{ec} is the maximum number of segments that can be delivered in one RTT. The gaming platform can wait for the client or server effective window to reach the value of V_{ec}, but once reached, the gaming platform requires them to be able to send 120Kbytes per RTT during the game. Does Juan's Internet connection fulfill with this?

[1] the windows that allows sending continuously considering the underlying transmission technology
[2] you can dismiss the ACK transmission time

sol: We have a link of 200Mbps and a propagation time of 3ms. We calculate the transmission time $t_{tx} = \frac{MTU}{v} = \frac{1500*8}{200*10^6} = 0{,}06\text{ms}$, and the ACK transmission time, that can be dismissed. The continuous sending windows has the expression $V_{ec} = \frac{RTT}{t_{tx}} = 1 + \frac{2*tp}{ttx}$ and its value $V_{ec} = 1 + \frac{2*3*10^{-3}}{0{,}06*10^{-3}} = 101$ segments.

Once the value of V_{ec} has been reached, both client and server[3] could send 101 segments per RTT. Since every segment can contain up to 1460 bytes ($MSS = MTU - 40 = 1460$), $101 * 1460 = 147460 bytes = \frac{147460}{1024} = 144{,}0039 KBytes$ can be sent per RTT, so Juan can play considering that requirement.

3. How long (in RTTs) would it take the effective window to reach the continuous delivery window (V_{ec})? The gaming platform requires the client to reach that window in less than 300ms. Does Juan's Internet connection fulfill with this?

   sol: Since *cwnd* will grow unlimited, the amount of segments that can be delivered per RTT will be limited by WIN (flow control) or by V_{ec} (physical limit). In this case, as V_{ec} is lower than WIN, WIN will not limit before V_{ec} is reached.

   Thus, the effective window $V_{ef} = min(cwnd, WIN)$ will be equal to *cwnd* during the time it takes to reach V_{ec}. *cwnd* will grow according to slow start until it reaches the value of $64 = ssthresh$, and according congestion avoidance from therein after. It will take 6 RTT to reach the value of 64. Then, every RTT it value will be incremented by 1[4], so it will take $101 - 64 = 37$ RTTs to reach V_{ec}. In total, it will be $37 + 6 = 43$ RTTs.

   Since a RTT in this connection is $RTT = t_{tx} + 2 * t_p = 0{,}06 * 10^{-3} + 2 * 3 * 10^{-3} = 6{,}06 * 10^{-3} = 6{,}06\text{ms}$, the total time will be $43 * 6{,}06 ms = 260\text{ms}$. Thus, it fulfills the requirement.

4. Juan is quite concerned about security, so he hired a firewall service with his internet connection. The problem is that the firewall is misconfigured and eliminates the first SYN segment (the first segment of the TCP connection establishment) the client delivers to the online gaming platform, producing a timeout. How does it affect Juan's connection? Would his connection be able to reach (V_{ec}) in the required time?

   sol: If the first SYN segment gets lost, a timeout will happen. No other type of congestion can happen as the connection has not been established yet, so data can't flow and can't generate ACKs. So, in the event of a timeout, the congestion windows will be set to 1 (in this case does not change as it was already 1), but the slow start threshold will drop to $ssthresh = max(\frac{V_{ef}}{2}, 2) = 2$ segments. Thus, it will grow according to slow start until the *cwnd* reaches 3 (that is strictly bigger than $ssthresh$). After that time, it will increase according to congestion avoidance. For that reason, the time will comprise 2 RTTs for the slow start growth and approximately $101 - 3 = 98$ RTTs for the congestion avoidance stage. The total time will be 100 RTTs, that are 606 ms to reach V_{ec}.

   Juan will no longer be able to play games online due to this.

5. The Internet provider, that cannot fix the problem with the firewall, offers to every user of the online gaming platform the same speed but a better propagation time of 1ms ($t_p = 1ms$) instead of the original 3ms. Will Juan be able to play online games in this case?
   sol: In this case, the RTT will be $RTT = 2t_p + t_{tx} = 2{,}06ms$ and $V_{ec} = \frac{RTT}{t_{tx}} = 1 + \frac{2*t_p}{t_{tx}} = 1 + \frac{2*1*10^{-3}}{0{,}06*10^{-3}} = 34{,}33 \approx 34$. In this case, the time to reach V_{ec} will be approximately $34 - 3 = 31$ RTTs in congestion avoidance and 2 RTTs in slow start, so 33 RTTs in total, that are $33 * 2{,}06ms = 67{,}98ms$, that is below the limit of $300ms$.

[3] both endpoints, according to the statement, are supposed to deliver enough information to reach that value

[4] $cwnd_n = cwnd_{n-1} + \frac{1}{cwnd_{n-1}}$, so every ACK increases the windows by $\frac{1}{cwnd_{n-1}}$ requiring approx. $cwnd_{n-1}$ ACKs to increase the value by 1

However, the amount of information that can be delivered, will be 34 segments per RTT, so $34 * 1460 = 49640 = 48,47$ Kbytes, that way less than the required 120Kbytes.

Cuestión

1. DNS – theorical question – not solved