Homework 4 Discussion
CSE123 Winter 2021

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Fair Queueing

Consider the network shown below. R1, R2, and R3 are routers and 1, 2, 3, 4 and 5 are hosts. The id and capacity (bandwidth) of each link (in Mbps) are labeled. Suppose 1, 2, 3 and 4 only send packets to 5 while 5 does not send any packets.

a) If you want to choose a link and increase the bandwidth to fully utilize the link G, which link would you increase the bandwidth the first?
Fair Queueing

b) Suppose R1 receives the following packets in the order listed at about the same time. Assume all incoming queues are empty and large enough to keep all receiving packets. (No dropping) The output port is busy.

<table>
<thead>
<tr>
<th>Packet</th>
<th>Size (in bytes)</th>
<th>Flow</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>300</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>120</td>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>150</td>
<td>C</td>
<td>4</td>
</tr>
</tbody>
</table>

Give the order in which these packets leave R1 if fair queueing is applied.
<2, 4, 3, 1, 5>

Give the order in which these packets leave R1 if weighted fair queueing is applied.
<4, 2, 5, 3, 1>
Random Early Detection

Consider a RED gateway, where the probability that a packet is dropped when the average queue size is equal to the maximum threshold size of the queue is 10%. Also assume that at the moment the average queue length is a quarter of the distance between the minimum threshold and the maximum threshold. Calculate the drop probability if the number of newly arrived packets in the queue is 30.

\[
TempP = \frac{\text{avgLength} - \text{min}_{th}}{\text{max}_{th} - \text{min}_{th}} \times p
\]

Drop probability of the \( i \)-th packet:

\[
p_i = \frac{TempP}{1 - i \times TempP}
\]
Congestion Control

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (RTT)</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>14</td>
<td>15</td>
<td>29</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>CWND</td>
<td>1</td>
<td>8</td>
<td>32</td>
<td>16</td>
<td>24</td>
<td>12</td>
<td>26</td>
<td>1</td>
<td>16</td>
</tr>
</tbody>
</table>
MAC Protocols (Slotted Aloha)

- Assuming a fixed frame size, the probability that one frame can be sent successfully in a slot in slotted Aloha with \( n \) users (efficiency of slotted Aloha) can be derived as follows:

\[
E(p) = np(1 - p)^{n-1} = np(1 - p)^{n-1}
\]

- This is also the probability that one user (not a specific one) has a successful transmission in a slot.

- Transmission probability \( p \) which maximizes the efficiency of the network:

\[
\frac{dE(p)}{dp} = 0 \rightarrow n(1 - p)^{n-1} - n(n - 1)p(1 - p)^{n-2} = 0 \rightarrow n - n^2p = 0 \rightarrow p = \frac{1}{n}
\]
MAC Protocols (Pure Aloha)

\[ E(p) = n p (1 - p)^{n-1} (1 - p)^n = n p (1 - p)^{2n-1} \]
Suppose a channel has a bandwidth of 13 MHz. What is the minimum required signal-to-noise ratio (in dB) that could deliver an effective bandwidth of at least 117 Mbps?

\[
SNR = 2^{C/B} - 1 = 511
\]
\[
SNR(dB) = 10\log_{10}SNR = 27.1\ dB
\]