UNDERSTANDING TCP FAIRNESS OVER WIRELESS LAN

Review: Vamshidhar Dantu
Introduction

- Wireless LANs are increasing in usage
- Necessity to ensure fairness
- Problems faced
Initial Experiments

Uplink

Base station

Downlink

Data

Ack

<table>
<thead>
<tr>
<th>MTU</th>
<th># of up flows</th>
<th># of down flows</th>
<th>UDP flow</th>
<th>$R_u/R_d$</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>1.44</td>
<td>0.22</td>
</tr>
<tr>
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<td>2</td>
<td>–</td>
<td>1.58</td>
<td>0.23</td>
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<tr>
<td>1500</td>
<td>3</td>
<td>3</td>
<td>–</td>
<td>1.76</td>
<td>0.34</td>
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<tr>
<td>1500</td>
<td>4</td>
<td>4</td>
<td>–</td>
<td>1.80</td>
<td>0.27</td>
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<tr>
<td>1500</td>
<td>2</td>
<td>2</td>
<td>500/2ms</td>
<td>1.79</td>
<td>0.35</td>
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<td>2</td>
<td>2</td>
<td>1000/2ms</td>
<td>2.15</td>
<td>0.55</td>
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<tr>
<td>500</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>1.77</td>
<td>0.39</td>
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<tr>
<td>500</td>
<td>2</td>
<td>2</td>
<td>–</td>
<td>1.83</td>
<td>0.38</td>
</tr>
<tr>
<td>500</td>
<td>3</td>
<td>3</td>
<td>–</td>
<td>1.87</td>
<td>0.41</td>
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<tr>
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<td>1</td>
<td>450/1ms</td>
<td>3.05</td>
<td>0.83</td>
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<tr>
<td>500</td>
<td>2</td>
<td>2</td>
<td>450/1ms</td>
<td>7.9</td>
<td>4.57</td>
</tr>
</tbody>
</table>
Experiment Finding:

- Uplink to Downlink ratio was more than 1.
- The upstream window reaches max size while downstream window changes.
Simulation

- Why Simulation?
- Result for one up and one down stream..

Below 6

BTW 6 and 42

42 to 84

At 84

Total TP (in Mbps)
ACK vs DATA drop probability
Modeling TCP

- $B \rightarrow$ Buffer Size, $w \rightarrow$ window size.
- Upstream flow reaches max $w$, while downstream varies w.r.t $B$ and $w$. $Y$?
Number of ACK’s in the buffer is at max $\alpha w$. 
Slots for downstream = $B - \alpha w$. 
Average window size available = $3(B - \alpha w)/4$. 
Hence $R = 4w/(3(B - \alpha w))$. 
This gives the naïve ratio plot shown in the next slide.
Modeling TCP (More Accurate)

- Use Bounded size queuing system. (M/M/1/K) system.

\[ R = \frac{-1}{3B} + \frac{4 \cdot 2^{\frac{2}{3}} w^2}{(81 B^2 w^4 + 81 B^3 w^4 - 4 w^6 + X)^{\frac{1}{3}}} \frac{12B}{12Bw^2} \]

where \( X = \sqrt{w^8 \left( -16 w^4 + (81 B^2 + 81 B^3 - 4 w^2)^2 \right)} \).

- With \( w \) is 42.

- This is a reasonable fit (computed ratio in the previous plot) to the actual curve.
Solutions

- Have separate queue's for ACK and Data at base station
  - Not feasible.
- Add DUP ACK's and/or Delete upstream data packets.
  - Effects????
- To set the upstream receive buffer, communicate through ACK's manipulated at base station to min([B/n], a(cwnd)).
  - \( n \rightarrow \) number of flows.