Quantifying stream distortion in 7-hop Fast Ethernet network

Max Azarov

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Consider 5 port switch with regulator before priority output queue

Output port receives measured steam and 3 interfering streams @ 18.75% each = 75% max load
Method of analysis

- To do quantitative analysis, we use graphical method with envelope charts
  - Network is running STP
  - Measured stream traverses full diameter of the network (7 hops)
  - For output port there’s 4 input streams, \( \frac{1}{4} \) of total allowable bandwidth each (\( 75%/4=18.75% \)), among them is a measured stream
  - Each input stream initially has a leaky-bucket envelope. We take this as a distortion level 0
  - We evaluate envelope of the measured stream on the output. Output has a distortion level +1
    - In our model, combined input traffic experiences maximum queuing delay, at which point interfering streams cease and only measured stream continues
    - This inflicts maximum level of distortion on the measured stream (needs a prove)
  - Same repeated on the next switch with interfering streams with a new increased distortion level until whole network is traversed
- Gives quantitative estimate of a queuing delay
- Yet to provide a worst-case proof
Distortion level distribution in a 3-hop network

- For streams traversing whole network diameter end-to-end
  - Maximum distortion level of interfering streams raises as measured stream approaches STP root switch
  - Starts to fall as measured stream progresses away from the root towards the edge
We are on 7-hop network with STP

Numbers are max distortion levels for streams coming from Downlink/Uplink

Circle – switch
Rectangle – end point
Switch 1 - input dist-n: 0/0 (measured/interfering)

- Summary incoming traffic
- Summary traffic worst-case TX rate
- Measured stream slope
- Measured stream output rate
- Measured stream input rate
- Input regulator rate
- 3 downlink interfering streams

Note: To get ms, units are multiplied by 0.38
Switch 2 - input dist-n: 1/1 (measured/interfering)

At this point interfering streams cease and we track a measured stream.

Size of data

Time

0.98

Summary incoming traffic
Summary traffic worst-case TX rate
Measured stream slope
Measured stream output rate
Measured stream input rate
Input regulator rate
3 downlink interfering streams
Switch 3 - input dist-n: 2/2 (measured/interfering)
Switch 4 (root) – dist-n: 3/3 (measured/interfering)
Switch 5 - input dist-n: 4/2 (measured/interfering)
Switch 6 - input dist-n: 5/1 (measured/interfering)
Switch 7 - input dist-n: 6/0 (measured/interfering)
End-to-end delays

End-end delay (ms)

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<th>4-port</th>
<th>5-port</th>
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<tr>
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<td>2.68</td>
<td>2.791667</td>
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Latency vs hop number

4-port switches

5-port switches
To-do

- Look at the case with regulators on the input, located before switching fabric
- Need formal proof for worst-case, i.e. need to provide definitive negative answer for:
  - Can other interfering stream bandwidth allocations cause bigger delay?
    - Perhaps equal distribution is not the most disadvantageous after all
  - Can measured stream traversing shorter path on the network experience bigger delay?
    - On one of the hops, such stream may experience interference from uplink with higher maximum distortion level, but on the other hand, it will pass through less hops overall
References

- Traffic envelopes and regulators
Questions?