Worst-case latency in 802.1Qav Ethernet bridges (v1 – very preliminary)

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This calculation is only for Class A
- I want to make sure we understand the limits on a “2ms” latency network
- Once we understand that, then I’ll add the Class B traffic to the analysis

The parameters to be explored include:
- Network topology (number of bridges and number of ports on each bridge)
- Stream packet limitations (max packet size)

For NOW all links are only 100Mbit/sec
All shapers are as described in Qav 0.3
Input, output & methodology

• The input parameters to be explored include:
  – Network topology (number of bridges and number of ports on each bridge)
  – Stream packet limitations (max packet size)
• Output is worst case delay
• Looking only at first order effects
  – mention will be made of 2\textsuperscript{nd} order effects that are being ignored for now
Talker model

- Talker consists of transport protocol packetizers feeding into stream shapers feeding into class shaper
- Stream shapers have infinite "sendSlope"
- Sum of all stream’s "idleSlope" is the class “idleSlope”
  - SRP bandwidth allocation is “idleSlope”
Same as a talker with no stream shapers
- Conversely, a talker can be thought of as a bunch of single stream sources each with an infinitely fast link to a bridge
Talker delays

- Talker has just started to transmit a best effort frame of \( b \) bytes
- There are \( m \) streams, each with a max packet size of \( s_j \) bytes
- Egress port rate is \( e \) bytes/sec
- Delay is

\[
\left( b + \sum_{i=1}^{m} s_i \right) \frac{1}{e}
\]
Bridge delays

• Bridge has just started to transmit a best effort frame of $b$ bytes

• There are $m$ ports, each routing class A traffic with a max packet size of $s_j$ bytes through the egress port

• Egress port rate is $e$ bytes/sec

• Delay is

\[
\frac{\left( b + \sum_{i=1}^{m} s_i \right)}{e}
\]
Network delays

• There are \( n \) bridges
  – so there are \( n+1 \) devices for queuing delays

• For each hop between devices there is no common stream
  – so it’s possible for a stream to always be delayed by new interfering packets on each hop

\[
\sum_{j=0}^{n} \left( \left( b_j + \sum_{i=1}^{m} S_{ij} \right) / e_j \right)
\]

• Delay is
Simplification

- all links are 100 Mbit/sec \( (e_j) \)
- worst case best effort interfering packet of 2048 bytes \( (b_j) \)
- all other class A packets are the same size \( (s_{ij}) \)
- the talker launches \( m \) streams and each bridge has \( m+1 \) ports
- so, delay is

\[
\frac{(n + 1)(b + ms)}{e} = \frac{(n + 1)(2048 + ms)}{100}
\]
2nd order effects

• Cumulative “bunching”?  
  – I don’t think this is a problem since I’m forcing the interfering traffic on each hop to be uncorrelated (not following the measured stream on any other link)
Max network delays

<table>
<thead>
<tr>
<th>#ports</th>
<th>16</th>
<th>8</th>
<th>4</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>max pkt</td>
<td>99</td>
<td>199</td>
<td>395</td>
<td>792</td>
<td>1500</td>
</tr>
</tbody>
</table>

- Delay > 2ms
- Packet size > 1500

max stream packet size for n=7
Conclusions

- Class 5 max packet size directly affects the latency, as does the number of bridges in a path from talker to listener, as does the number of ports on those bridges
  - We have been assuming 7 hops is a good limit for class A at 2ms max delay.
  - So we need to assume limits for the number of ports on the bridges and the max packet size
- For a 7 hop 100 Mbit/sec Ethernet configuration, we should perhaps assume 8 port bridges are a maximum
  - If so, then class 5 packets need to be no larger than about 200 bytes
- SRP *can* allow larger packets, but it will have to be ready to deny requests even when there is bandwidth available on a egress port
  - because the latency budget of “250 usec/bridge” is used up