Simulation Results for 3sm

draft-babiarz-pcn-explicit-marking-01

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Update

> Added additional explanation of simulation setup that is used to verify performance of admission control and flow termination.
  • Moved metering and marking to 3sm draft.

> Flow Termination
  • Performance in single and multi domain network
    • Large and small number of flows; CBR and VBR traffic mix.

> Admission Control
  • Summarized results with 2x overload, Poisson arrivals, 20 minutes (10 x 2)

Flow Termination
Summarized Results.

Convergence time for overload removal in response to a step overload

<table>
<thead>
<tr>
<th>Sim#</th>
<th>SR</th>
<th>Traffic</th>
<th>RTT</th>
<th>&quot;S&quot;</th>
<th>150%</th>
<th>125%</th>
<th>110%</th>
<th>100%</th>
<th>AVG</th>
<th>Max</th>
<th>Min</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>JB372</td>
<td>40Mbps</td>
<td>G.711CBR</td>
<td>50</td>
<td>1064</td>
<td>0.15</td>
<td>0.2</td>
<td>0.25</td>
<td>0.5</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>JB373</td>
<td>40Mbps</td>
<td>3VBR+CBR</td>
<td>50</td>
<td>1064</td>
<td>0.15</td>
<td>0.2</td>
<td>0.3</td>
<td>~2</td>
<td>38.9</td>
<td>41.7</td>
<td>36.7</td>
<td>5</td>
</tr>
<tr>
<td>JB370</td>
<td>0.8Mbps</td>
<td>G.711CBR</td>
<td>50</td>
<td>1064</td>
<td>0.2</td>
<td>0.25</td>
<td>0.3</td>
<td>0.4</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>JB371</td>
<td>0.8Mbps</td>
<td>3VBR+CBR</td>
<td>50</td>
<td>1064</td>
<td>0.25</td>
<td>0.35</td>
<td>0.40</td>
<td>~2</td>
<td>0.74</td>
<td>1.07</td>
<td>0.50</td>
<td>0.57</td>
</tr>
<tr>
<td>JB360</td>
<td>40Mbps</td>
<td>G.711CBR</td>
<td>50</td>
<td>2064</td>
<td>0.15</td>
<td>0.3</td>
<td>0.45</td>
<td>1.2</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>JB361</td>
<td>40Mbps</td>
<td>3VBR+CBR</td>
<td>50</td>
<td>2064</td>
<td>0.2</td>
<td>0.35</td>
<td>0.85</td>
<td>~3</td>
<td>38.9</td>
<td>41.8</td>
<td>36.3</td>
<td>5.5</td>
</tr>
<tr>
<td>JB364</td>
<td>0.8Mbps</td>
<td>G.711CBR</td>
<td>50</td>
<td>2064</td>
<td>0.3</td>
<td>0.4</td>
<td>0.6</td>
<td>0.65</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>JB365</td>
<td>0.8Mbps</td>
<td>3VBR+CBR</td>
<td>50</td>
<td>2064</td>
<td>0.3</td>
<td>0.35</td>
<td>0.45</td>
<td>~4</td>
<td>0.74</td>
<td>1.05</td>
<td>0.51</td>
<td>0.54</td>
</tr>
<tr>
<td>JB268</td>
<td>40Mbps</td>
<td>G.711CBR</td>
<td>200</td>
<td>4064</td>
<td>0.45</td>
<td>0.65</td>
<td>0.9</td>
<td>1.6</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>JB367</td>
<td>40Mbps</td>
<td>3VBR+CBR</td>
<td>200</td>
<td>4064</td>
<td>0.45</td>
<td>0.75</td>
<td>1.7</td>
<td>~4</td>
<td>38.9</td>
<td>42.3</td>
<td>36.1</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Fast Reroute with 150% overload.

<table>
<thead>
<tr>
<th>Sim#</th>
<th>SR</th>
<th>Traffic</th>
<th>RTT</th>
<th>&quot;S&quot;</th>
<th>150%</th>
<th>125%</th>
<th>110%</th>
<th>100%</th>
<th>AVG</th>
<th>Max</th>
<th>Min</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>JB326</td>
<td>40Mbps</td>
<td>G.711CBR</td>
<td>50</td>
<td>2064</td>
<td>-</td>
<td>0.2</td>
<td>0.35</td>
<td>1.05</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>JB327</td>
<td>40Mbps</td>
<td>3VBR+CBR</td>
<td>50</td>
<td>2064</td>
<td>-</td>
<td>0.2</td>
<td>0.4</td>
<td>~2</td>
<td>38.7</td>
<td>41.6</td>
<td>35.4</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Average rate was measured over 12 seconds.
"s" is in bytes
SR = 40 Mbps; TB size = 50K bytes
SR = 0.8 Mbps; TB size = 10K bytes
Token Bucket Parameter Setting
Supportable Rate = 40 Mbps
TB size = 50K bytes
Service Class BW limit = 100 Mbps
“s” = 1.064K bytes
Buffer size = 10,000 bytes

G711-20/CBR/0-Idle/40Mbps/50msRTT_2.5BW/mBF

Source rate
Transmitted rate
#Active flows

Observation time interval = 0.05 sec
Simulation # JB372
Token Bucket Parameter Setting
Supportable Rate = 40 Mbps
TB size = 50K bytes
Service Class BW limit = 100 Mbps
“s” = 1.064K bytes
Buffer size = 9,250 bytes

MixCodec/VBR/0-Idle/40Mbps/50msRTT_2.5BW/mBF

Observation time interval = 0.05 sec
Simulation # JB373
Token Bucket Parameter Setting
- Supportable Rate = 0.8 Mbps
- TB size = 10K bytes
- “s” = 1.064K bytes
- Service Class BW limit = 2 Mbps
- Buffer size = 9,250 bytes

MixCodec/VBR/0-Idle/0.8Mbps/50msRTT_2.5BW/mBF

![Graph showing BW Mbps and #Active flows over observation time interval]

- Source rate
- Transmitted rate
- #Active flows

Observation time interval = 0.05 sec
SR = 0.8 Mbps
Simulation # JB371
Admission Control Simulation Setup for Voice

Updated July. 2007

Simulation Model

Poisson arrivals (flows/sec + per-flow holding time) Arriving flow starts sending packets after a random media delay

“AS” Flag with Delay = RTT (2, 50, 200 ms)

Source rate & flow count monitoring point

Delay (RTT)

Transmitted rate monitoring point

Router

SRC

DST

Forwarding Rate and Queue Size
Rate: X times AR; Queue: unlimited or configurable

AC algorithm:
- Block admission on 1st AS-marked packet
- Resume admission on timeout if not receiving more AS flags in timeout

3sM & parameters:
AR in Mbps;
TB.size in K bytes;
TB.threshold in K bytes

Single codec type CBR
Flow #1
Flow #2
Flow # n

Mixed codec CBR (3 types, 1/3 each)
Flow #1
Flow #2
Flow # n

Mixed codec VBR (3 types, 1/3 each)
Flow #1
Flow #2
Flow # n

Flow monitoring point

Updated July. 2007
Simulation Parameters for Admission Control

> Test the proposed 3sm AR-meter/marker with fixed TB size and threshold and AR proportional to traffic load
  
  • Target flows: 10 and 200
  • RTT: 2 ms and 200 ms
  • Delay to media start: 0 and random up to 10 seconds
  • Codec: CBR vs. VBR (silence suppression)
# Admission Control
## Summarized Results

<table>
<thead>
<tr>
<th>Case</th>
<th>Target: Data Rate (Mbps) / Flows</th>
<th>AR (Mbps)</th>
<th>Flow Arrival Rate (flows/s)</th>
<th>Offered Load (Mbps)</th>
<th>RTT (ms)</th>
<th>Max Media Delay (s)</th>
<th>% Flow Blocked</th>
<th>Avg Flow Overshoot</th>
<th>Max Flow Overshoot</th>
<th>Data Rate to Target Rate Ratio</th>
<th>% Time Peak Rate Overshoot</th>
<th>Avg Peak Rate Overshoot (kbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR-10-a</td>
<td>0.8 / 10</td>
<td>0.72</td>
<td>0.375</td>
<td>1.8</td>
<td>2</td>
<td>0</td>
<td>56%</td>
<td>1.03</td>
<td>2</td>
<td>88%</td>
<td>5%</td>
<td>81.4</td>
</tr>
<tr>
<td>CBR-10-c</td>
<td>0.8 / 10</td>
<td>0.72</td>
<td>0.375</td>
<td>1.8</td>
<td>200</td>
<td>0</td>
<td>57%</td>
<td>1.75</td>
<td>5</td>
<td>98%</td>
<td>15%</td>
<td>79.4</td>
</tr>
<tr>
<td>CBR-200-a</td>
<td>16 / 200</td>
<td>15.92</td>
<td>7.5</td>
<td>36</td>
<td>2</td>
<td>0</td>
<td>57%</td>
<td>2.419</td>
<td>8</td>
<td>98%</td>
<td>19%</td>
<td>135.8</td>
</tr>
<tr>
<td>CBR-200-c</td>
<td>16 / 200</td>
<td>15.92</td>
<td>7.5</td>
<td>36</td>
<td>200</td>
<td>0</td>
<td>56%</td>
<td>1.43</td>
<td>4</td>
<td>88%</td>
<td>0.3%</td>
<td>35.8</td>
</tr>
<tr>
<td>VBR-10-a</td>
<td>0.32 / 10</td>
<td>0.28</td>
<td>0.375</td>
<td>0.7</td>
<td>200</td>
<td>0</td>
<td>60%</td>
<td>1.43</td>
<td>4</td>
<td>88%</td>
<td>0.3%</td>
<td>35.8</td>
</tr>
<tr>
<td>VBR-200-a</td>
<td>6.32 / 200</td>
<td>6.29</td>
<td>7.5</td>
<td>13.95</td>
<td>200</td>
<td>0</td>
<td>58%</td>
<td>3.765</td>
<td>13</td>
<td>95%</td>
<td>0.0%</td>
<td>47.3</td>
</tr>
<tr>
<td>CBR-10-b</td>
<td>0.8 / 10</td>
<td>0.72</td>
<td>0.375</td>
<td>1.8</td>
<td>2</td>
<td>10</td>
<td>54%</td>
<td>1.84</td>
<td>5</td>
<td>90%</td>
<td>17%</td>
<td>110.0</td>
</tr>
<tr>
<td>CBR-10-d</td>
<td>0.8 / 10</td>
<td>0.72</td>
<td>0.375</td>
<td>1.8</td>
<td>200</td>
<td>10</td>
<td>54%</td>
<td>1.798</td>
<td>5</td>
<td>90%</td>
<td>20%</td>
<td>108.1</td>
</tr>
<tr>
<td>CBR-200-b</td>
<td>16 / 200</td>
<td>15.92</td>
<td>7.5</td>
<td>36</td>
<td>2</td>
<td>10</td>
<td>55%</td>
<td>19.30</td>
<td>49</td>
<td>99%</td>
<td>43%</td>
<td>711.6</td>
</tr>
<tr>
<td>CBR-200-d</td>
<td>16 / 200</td>
<td>15.92</td>
<td>7.5</td>
<td>36</td>
<td>200</td>
<td>10</td>
<td>54%</td>
<td>20.33</td>
<td>53</td>
<td>99%</td>
<td>44%</td>
<td>804.2</td>
</tr>
<tr>
<td>VBR-10-b</td>
<td>0.32 / 10</td>
<td>0.28</td>
<td>0.375</td>
<td>0.7</td>
<td>200</td>
<td>10</td>
<td>57%</td>
<td>1.91</td>
<td>5</td>
<td>87%</td>
<td>0.4%</td>
<td>31.4</td>
</tr>
<tr>
<td>VBR-200-b</td>
<td>6.32 / 200</td>
<td>6.29</td>
<td>7.5</td>
<td>13.95</td>
<td>200</td>
<td>10</td>
<td>58%</td>
<td>13.87</td>
<td>56</td>
<td>96%</td>
<td>0.2%</td>
<td>122.7</td>
</tr>
</tbody>
</table>

In above table: AS-clear timer = 1sec.

| CBR-200-a*    | 16 / 200                         | 15.92     | 7.5                        | 36                  | 2         | 0                    | 56%            | 2.344             | 10                | 99%                         | 30%                         | 183.6                       |
| CBR-200-d*    | 16 / 200                         | 15.92     | 7.5                        | 36                  | 200       | 10                   | 54%            | 20.72             | 57                | 100%                        | 48%                         | 778.8                       |
| VBR-200-a*    | 6.32 / 200                       | 6.29      | 7.5                        | 13.95               | 200       | 0                    | 56%            | 6.025             | 25                | 100%                        | 0.2%                        | 98.5                        |
| VBR-200-b*    | 6.32 / 200                       | 6.29      | 7.5                        | 13.95               | 200       | 10                   | 55%            | 18.4              | 49                | 100%                        | 0.4%                        | 157.0                       |

In below table: AS-clear timer = 0.1sec.

In all cases: TB size=20 Kbytes; Threshold=10 Kbytes;
CBR=G.711/20ms-80kbps; VBR=G.711/20ms-silence suppression-32kbs; Mean Holding Time=60 s
Stats based on 10 two-minute-runs = 20 minutes
Token Bucket Parameter Setting
Admissible Rate = 0.72 Mbps
TB size = 20K bytes
Target Data Rate = 0.8 Mbps = 10 flows
Threshold = 10K bytes
Link BW = 1.6 Mbps Buffer size unlimited

Observation time interval = 0.04 sec for 120 sec at q_1s1
Token Bucket Parameter Setting
Admissible Rate = 15.92 Mbps
TB size = 20K bytes
Target Data Rate = 16 Mbps = 200 flows
Threshold = 10K bytes
Link BW = 32 Mbps Buffer size unlimited

G711-20/CBR/16Mbps/2msRTT_2BW/IBF

Source rate
Transmitted rate
#Active flows
#Blocked flows

Measured data rate = 15.7 Mbps; Flow blocking ratio = 0.57

Flow arrival rate = 7.5 flows/s
Mean holding time = 60 s
Total data rate = 36 Mbps
Media delay limit = 0 s

Observation time interval = 0.04 sec for 120 sec at q_1s1
Token Bucket Parameter Setting
- Admissible Rate = 6.29 Mbps
- Target Data Rate = 6.32 Mbps = 200 flows
- Link BW = 12.64 Mbps Buffer size unlimited

Observation time interval = 0.04 sec for 120 sec at q_1s1

### G711-20/VBR/6.33Mbps/200msRTT_2BW/IBFmd

- Source rate
- Transmitted rate
- #Active flows
- #Blocked flows

**Measured data rate:** 6.0 Mbps; Flow blocking ratio = 0.58

Flow arrival rate = 7.5 flows/s

Mean holding time = 60 s

Total data rate = 13.95 Mbps

Media delay limit = 10 s
Observation

> Flow Termination
  • Token bucket size:
    • Filters out burstness
  • “s” FT-marking reduction factor:
    • $S = \text{“average?” rate of flow} \times \text{RTT} \times 2$
    • It has the biggest impact on how fast or slow excess traffic is reduced
    • Setting “s” too small will cause over flow termination
  • Is effective when there are large or small number of flows at the congestion point

> Admission Control
  • Is effective in blocking new flows once in stop-admit state
  • Over admission is an issue
    • mostly due to delay in start of media (telephony application)
    • and TB.size – TB.treshold that is used to filter out burstness
  • TB.size – TB.treshold needs to be scaled to admissible rate (AR)
  • Multiple pre-congestion points and cross traffic (parking lot) had very little to no effect on AS-marking and admission control.
Further Work

> **Flow Termination**
  - Verify performance with multi congestion points and cross traffic “parking lot”
  - Provide guidelines on how to compute value for “s”

> **Admission Control**
  - Investigate if probing during flow setup can address the over admission issue.
  - Investigate performance when there are low number of highly variable flows at the pre-congestion point.