Update on RMCAT Video Traffic Model: Trace Analysis and Model Update

draft-ietf-rmcat-video-traffic-model-02

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Outline

• Setup for trace collection from modified Mozilla browser
• Analysis of transient and steady-state traces
• Proposed revision of statistical model parameters
• Next steps: updates to draft and Syncodecs
Setup: Test Video Sequence

Chat about Austin (Chat)

- Three people chatting about living in Austin
- Captured through Cisco Telepresence unit

- Original sequence:
  - Resolution: 1080p
  - Frame rate: 30 fps
  - Encoder: H.264
  - Encoding rate: 4.1 Mb/s
  - Duration: 6:34s

- Converted to yuv420p via ffmpeg:
  - First 7200 frames (4 minutes)
  - Multiple resolutions 1080p, 720p, 540p, 360p, 240p, 180p, 90p

Setup: Modified Mozilla Browser

• Reused source code changes presented in IETF-97: Codec disregards input from congestion controller and follows hardcoded bitrate pattern instead.

• Further code changes in VideoConduit.cpp:
  • Extended hard-coded bitrate pattern for the entire duration of 7200 frames.
  • For studying transient behavior: switching between 1Mbps and various target rates (+/- 20%, 40%, 60%, and 80%) in 10-second steps.
  • For studying steady-state behavior: cycling through all target rates at each resolution in one long running session (with looping video).
Setup: Trace Generation

- For each bitrate variation pattern, ran modified Mozilla browser at all resolutions using H.264 codec

- Observation: sometimes the codec misses output frames (root cause pending further investigation)

- Resolution:
  - Removed “unreasonable” configs (e.g., 1080p@100Kbps)
  - Multiple runs for each config and keep the most regular trace

- The format of output traces are compatible with Syncodecs
Setup: Screen Capture of Test HTML

Simple RTCPeerConnection Video Test

Stop:  Use Fake Audio/Video for reverse stream  Use Fake Audio/Video for forward stream  One-way call  Audio-only call  Video-only call

Disable video  Disable audio  Require H.264 video  Require G.722 audio

Video Constraints in JSON (use quotes!)

Enable Identity Provider: Domain  
Protocol  
User A Name  
User B Name  

Parsing JSON:

Offer: v=0
o=mozilla...THIS_IS_SDPARTA-50.0 2689953430245834322 0 IN IP4 0.0.0.0
a=recvonly
r=0 0
i=0

User A Name: 
User B Name: 

Video Constraints in JSON (use quotes!):

[]
Analysis of Transient and Steady-State Traces
Encoded Frame Size and Distribution of Frame Intervals

chat l h264@720p

Frame Size (KB)

Time (s)

AVG:  33.9 ms
STD:   8.1  ms

chat l h264@1080p

Frame Size (KB)

Time (s)

AVG:  34.7 ms
STD:  10.2  ms
Transition between 1Mbps and 1.2Mbps (+/- 20%)

chat | h264@720p
Burst frame size: 13.7 KB
Burst duration: 7 frames

chat | h264@1080p
Burst frame size: 20.1 KB
Burst duration: 8 frames

chat | h264@720p
Burst frame size: 13.6 KB
Burst duration: 7 frames

chat | h264@1080p
Burst frame size: 20.2 KB
Burst duration: 6 frames
Transition between 1Mbps and 1.6Mbps (+/- 60%)

chat l h264@720p

Burst frame size: 13.5 KB
Burst duration: 8 frames

chat l h264@1080p

Burst frame size: 19.9 KB
Burst duration: 10 frames

chat l h264@720p

Burst frame size: 13.7 KB
Burst duration: 10 frames

chat l h264@1080p

Burst frame size: 20.1 KB
Burst duration: 8 frames
## Details Statistics on Burst Frame Size and Duration

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Start Rate (Kbps)</th>
<th>Target Rate (Kbps)</th>
<th>K_B: Burst Frame Size (K_B, in KB)</th>
<th>Burst Duration (K_d, in # of Frames)</th>
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<td></td>
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<td>720p</td>
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<td><strong>Range of Value</strong></td>
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<td></td>
<td><strong>11.5 - 16.3</strong></td>
<td><strong>19 - 23.1</strong></td>
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Overview of Steady-State Traces: Target Rate vs. Actual Rate

Ratio of Actual vs. Target Rate

<table>
<thead>
<tr>
<th>%</th>
<th>100 Kbps</th>
<th>200 Kbps</th>
<th>400 Kbps</th>
<th>600 Kbps</th>
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Legend:
- <50%
- 50-75%
- 75-100%
Overview of Steady-State Traces: Relative Rate Variations

Observations:
• For a given rate, relative rate variation decreases with higher resolutions;
• For a given resolution, relative rate variation increases with higher rates.
Example Trace and Histogram: 600 Kbps @ 360p

Frame Size (KB)

Frame Interval (ms)

Probability (%)
Example Trace and Histogram: 600 Kbps @ 540p

Frame Size (KB)

Frame Interval (ms)

Laplacian: SCALE_B = 14.5%

Laplacian: SCALE_t = 13.1%
Example Trace and Histogram: 600 Kbps @ 720p
Example Trace and Histogram: 600 Kbps @ 1080p

600 kbps @ 1080p

Frame Size (KB)

0 1 2 3 4 5
0 50 100 150 200

Probability (%)

0 10 20 30 40
0 5 10 15

Frame Size (KB)

Laplacian: SCALE_B = 5.5 %

Laplacian: SCALE_t = 12.3%
Laplace Distribution of Frame Size and Intervals

### SCALE_B for Frame Size Distributions

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Range of values: 5-23%

### SCALE_t for Frame Interval Distributions

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Range of values: 10-20%
Proposed Model Revisions and Next Steps
Revised Statistical Traffic Model and Updates to video-traffic-model

- Transient behavior characterized by burst frame size ($K_B$) and duration ($K_t$) [updated in Jan 2017]

- Laplace distribution of frame intervals:
  - $t_0$ — reference interval determined by average frame rate: $1/\text{FPS}$
  - $\text{SCALE}_t$ — scaling parameter of normalized frame interval ($t/t_0$): 10-20% [Default: 15%]

- Laplace distribution of steady-state frame sizes
  - $B_0$ — reference frame size determined by target rate and frame rate: $R/8/\text{FPS}$
  - $\text{SCALE}_B$ — scaling parameter of normalized frame size ($B/B_0$): 5-23% [Default: 15%]
Update to Syncodecs

- Corresponding code changes to reflect revised statistical model
- New group of traces collected from the modified Mozilla browser using the Chat video sequence (encoded with H.264)
- Stay in tuned via mailing list and at https://github.com/cisco/syncodecs