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

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

Xiaoqing Zhu, Sergio Mena, and Zahed Sarker

April 2017 | IETF RMCAT Virtual Interim

# 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

**https://www.ietf.org/proceedings/97/slides/slides-97-rmcat-video-traffic-model-02.pdf**

# Setup: Modified Mozilla Browser

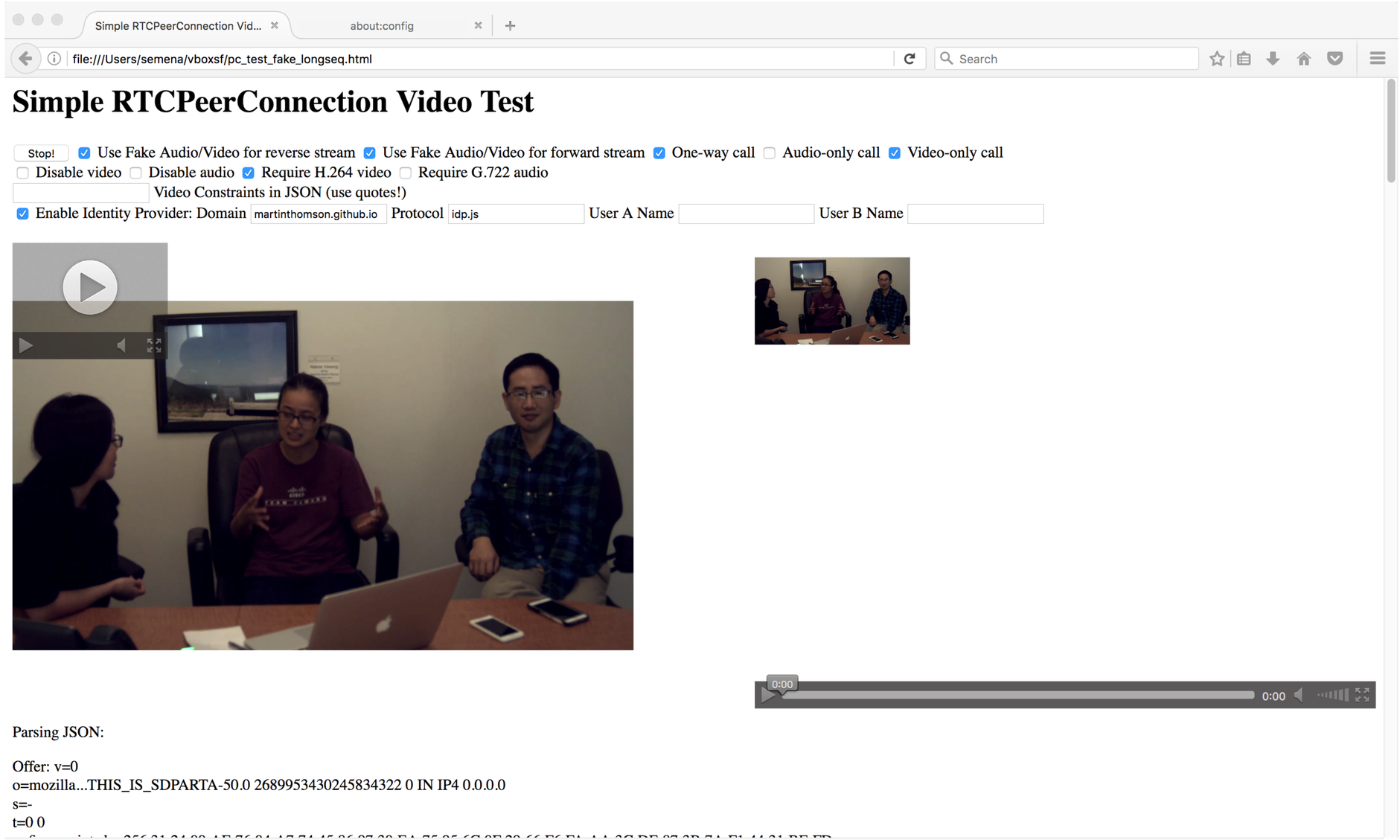
- Reused source code changes presented in IETF-97: Codec disregards input from congestion controller and follows hardcoded bitrate pattern instead

- 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

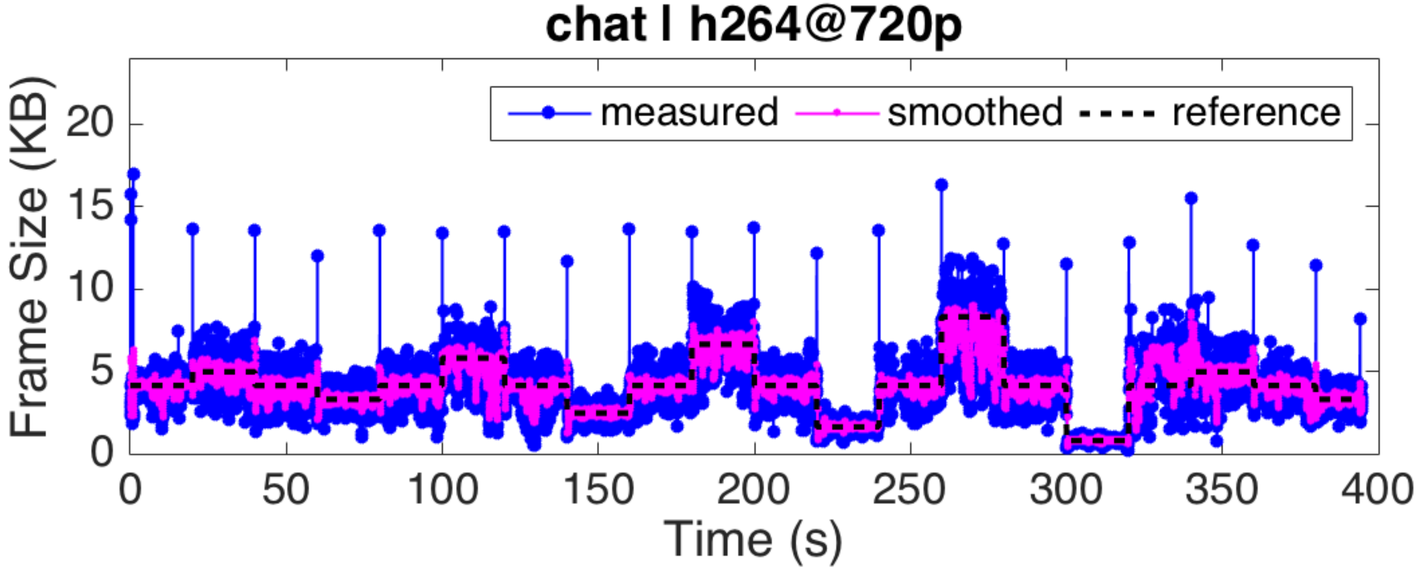
- For each bitrate variation pattern, ran modified Mozilla browser at all resolutions using H.264 codec
- Observation: sometimes the codec misses output frames (root cause pending further investigation)
- Resolution:
  - Removed “unreasonable” configs (e.g., 1080p@100Kbps)
  - Multiple runs for each config and keep the most regular trace
- The format of output traces are compatible with S*yncodecs*

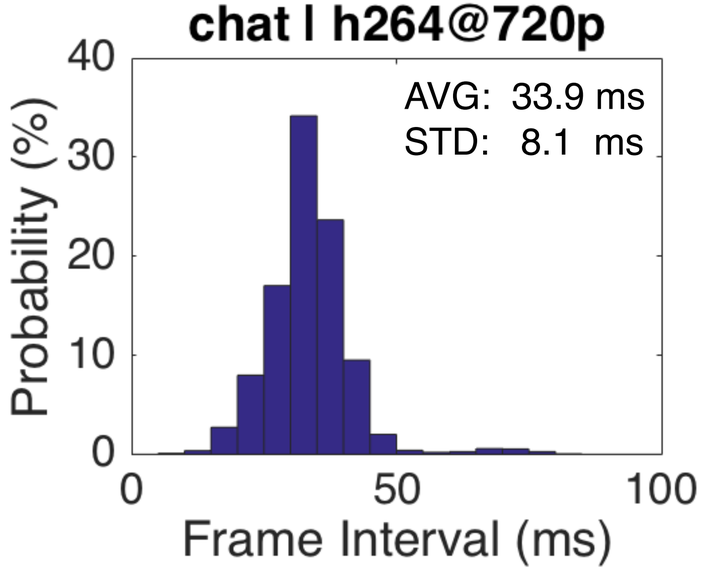
# Setup: Screen Capture of Test HTML

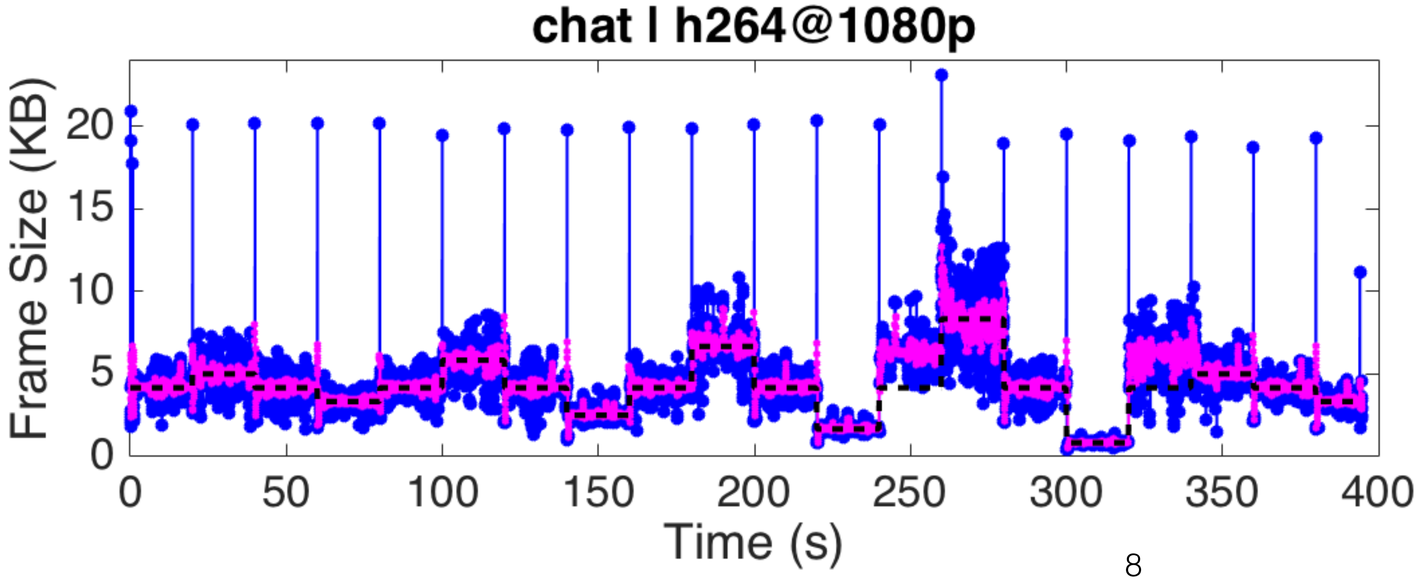


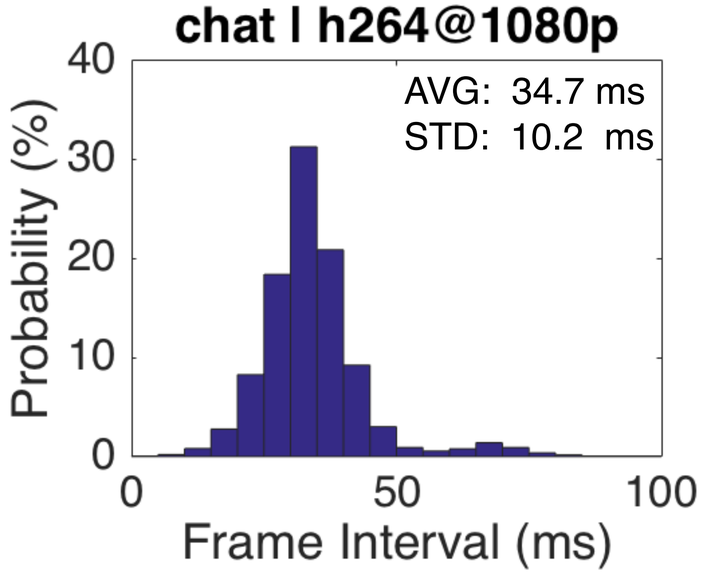
# Analysis of Transient and Steady-State Traces

# Encoded Frame Size and Distribution of Frame Intervals

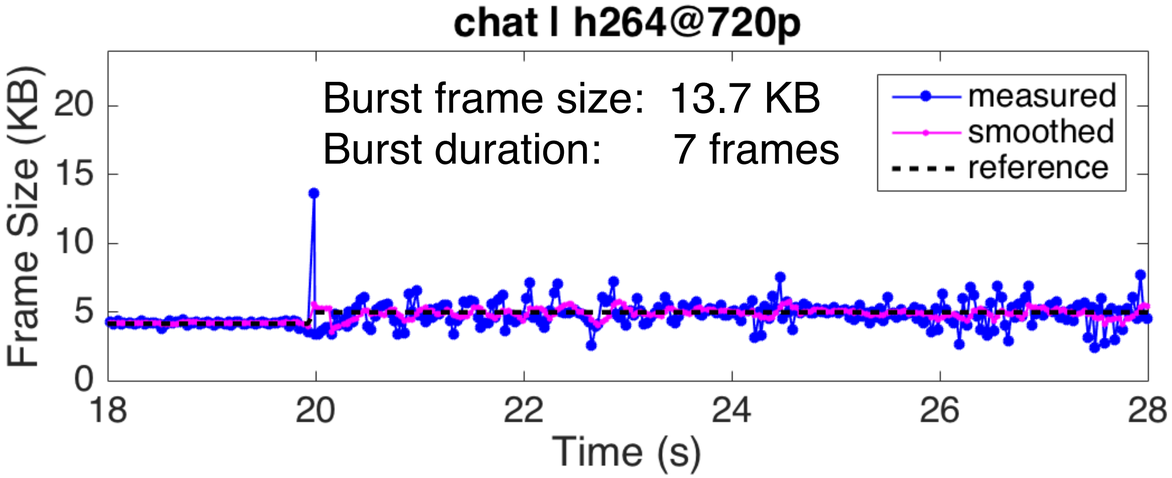


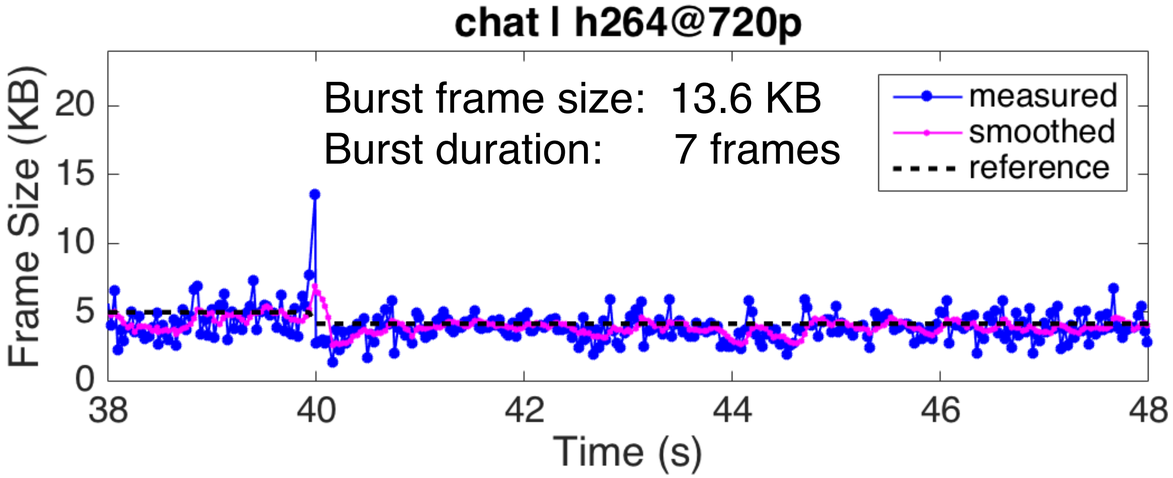



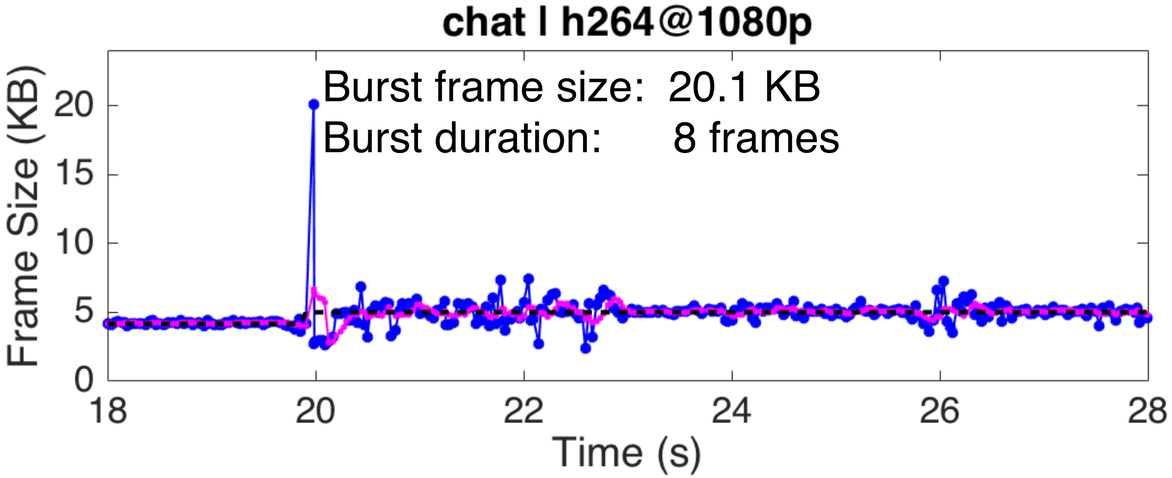



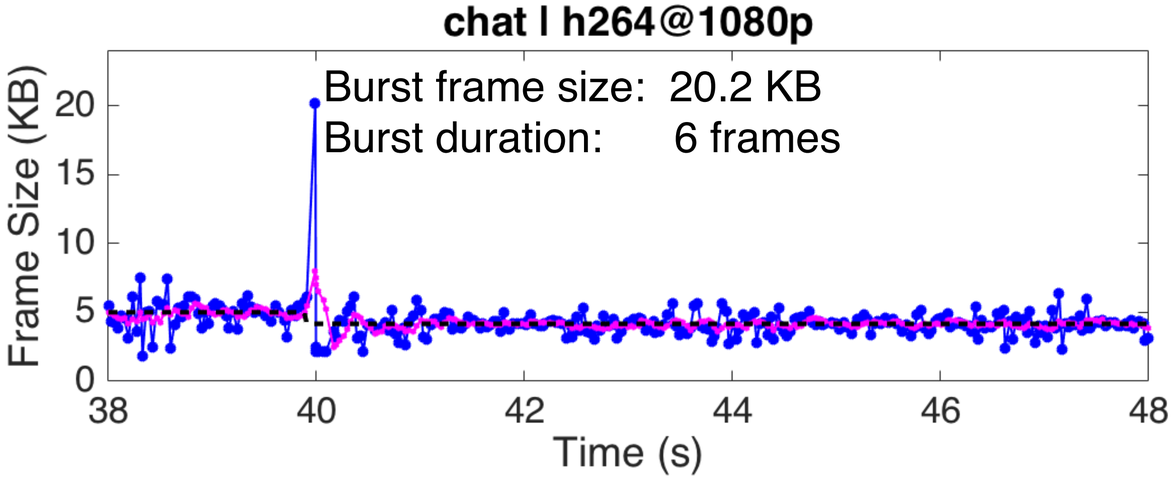



# Transition between 1Mbps and 1.2Mbps (+/- 20%)

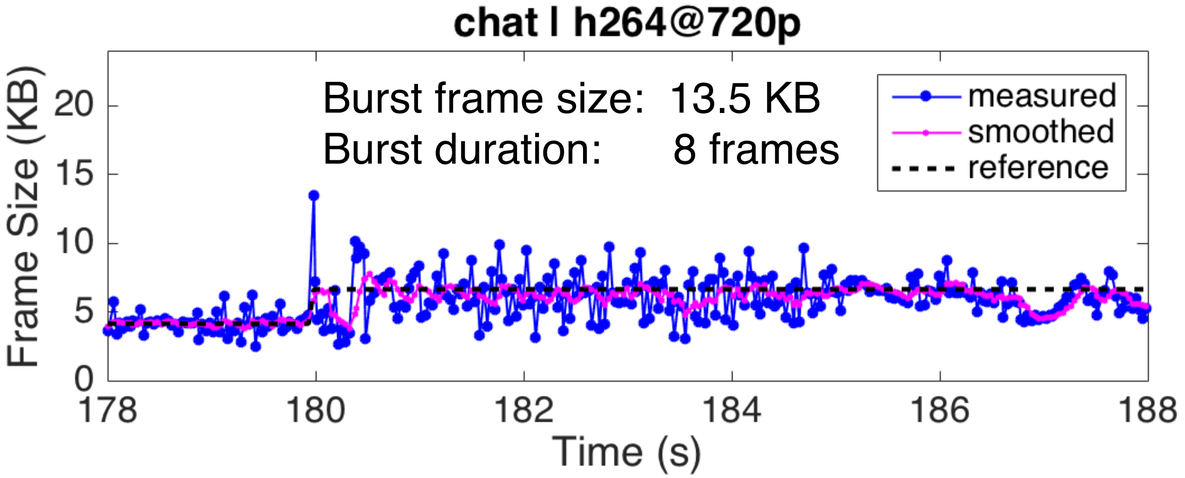


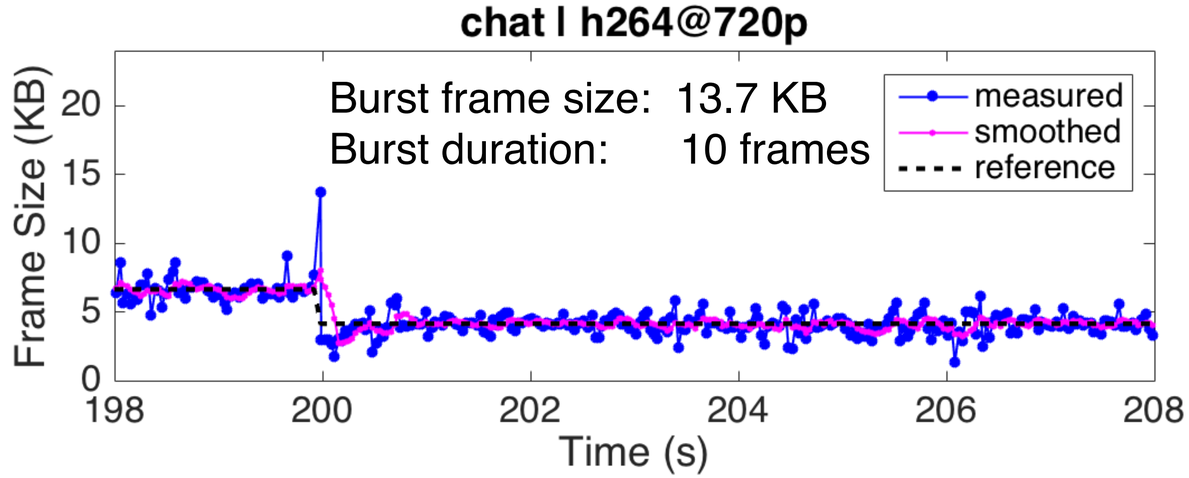



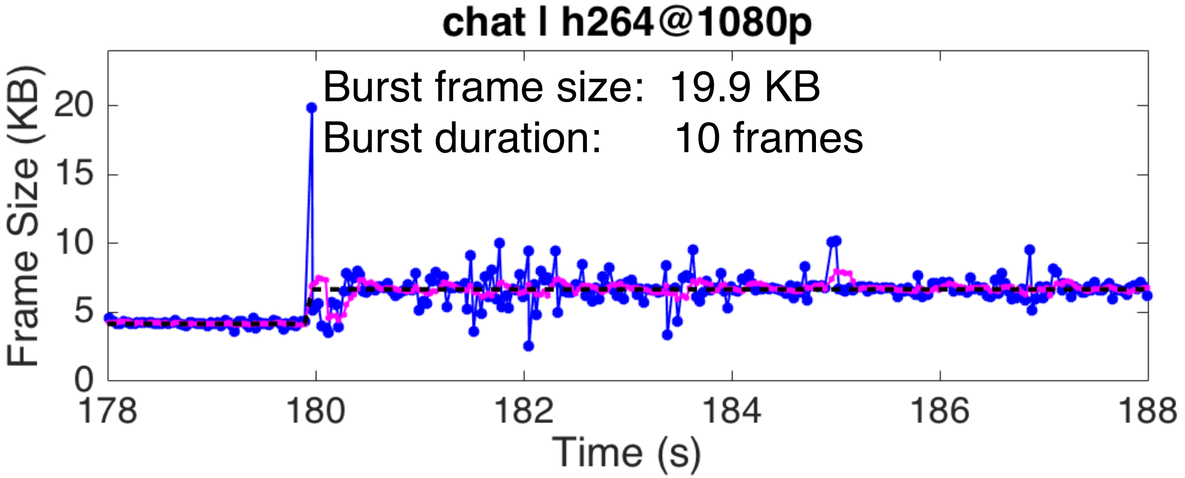



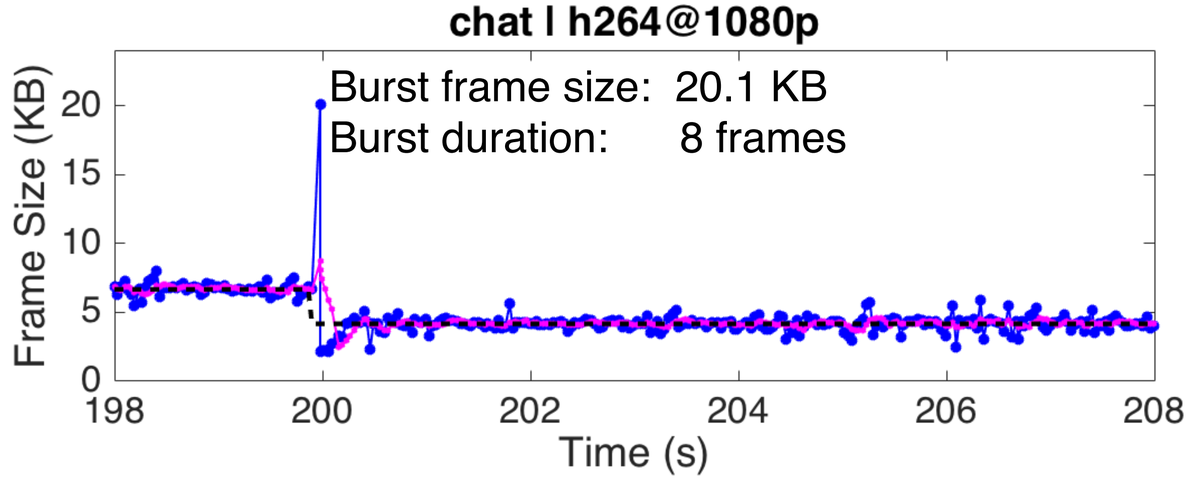



# Transition between 1Mbps and 1.6Mbps (+/- 60%)



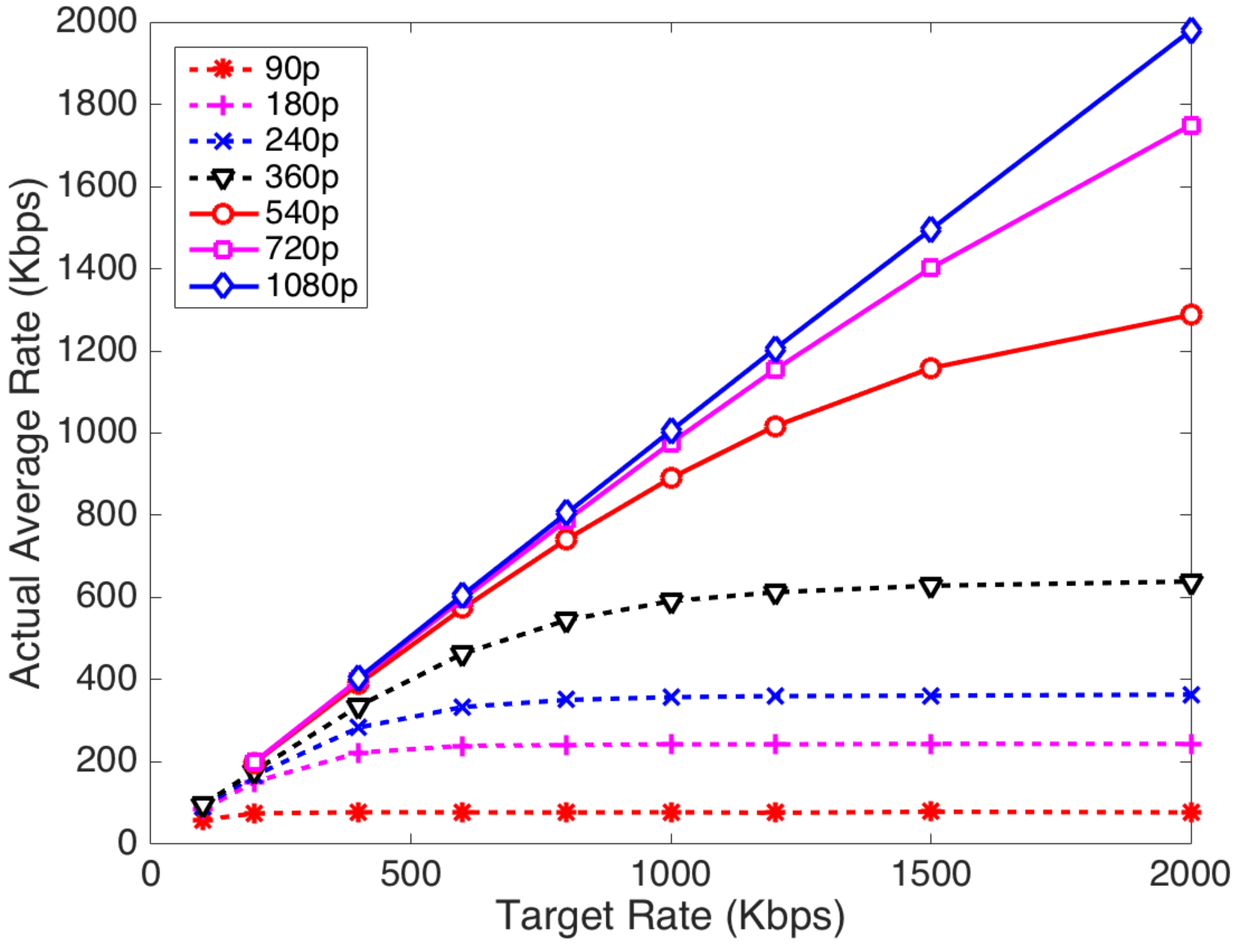



# Details Statistics on Burst Frame Size and Duration

| Time (s) | Start Rate (Kbps) | Target Rate (Kbps) | K_B: Burst Frame Size (K_B, in KB) | | Burst Duration (K_d, in # of Frames) | |
|---|---|---|---|---|---|---|
| | | | 720p | 1080p | 720p | 1080p |
| **20** | **1000** | **1200** | 13.7 | 20.1 | 7 | 8 |
| **40** | **1200** | **1000** | 13.6 | 20.2 | 7 | 6 |
| **60** | **1000** | **800** | 12.0 | 20.2 | 8 | 8 |
| **80** | **800** | **1000** | 13.6 | 20.1 | 10 | 5 |
| **100** | **1000** | **1400** | 13.4 | 19.5 | 8 | 9 |
| **120** | **1400** | **1000** | 13.5 | 19.9 | 8 | 8 |
| **140** | **1000** | **600** | 11.7 | 19.7 | 8 | 8 |
| **160** | **600** | **1000** | 13.7 | 20.0 | 10 | 7 |
| **180** | **1000** | **1600** | 13.5 | 19.9 | 8 | 10 |
| **200** | **1600** | **1000** | 13.7 | 20.1 | 10 | 8 |
| **220** | **1000** | **400** | 12.2 | 20.4 | 8 | 8 |
| **240** | **400** | **1000** | 13.4 | 20.1 | 7 | 2 |
| **260** | **1000** | **2000** | 16.3 | 23.1 | 2 | 2 |
| **280** | **2000** | **1000** | 12.8 | 19.0 | 7 | 8 |
| **300** | **1000** | **200** | 11.5 | 19.5 | 8 | 4 |
| **320** | **200** | **1000** | 12.9 | 19.2 | 2 | 2 |
| **Median Value** | | | **13.5** | **20.1** | **8** | |
| **Range of Value** | | | **11.5 - 16.3** | **19 - 23.1** | **2-10** | |

# Overview of Steady-State Traces: Target Rate vs. Actual Rate

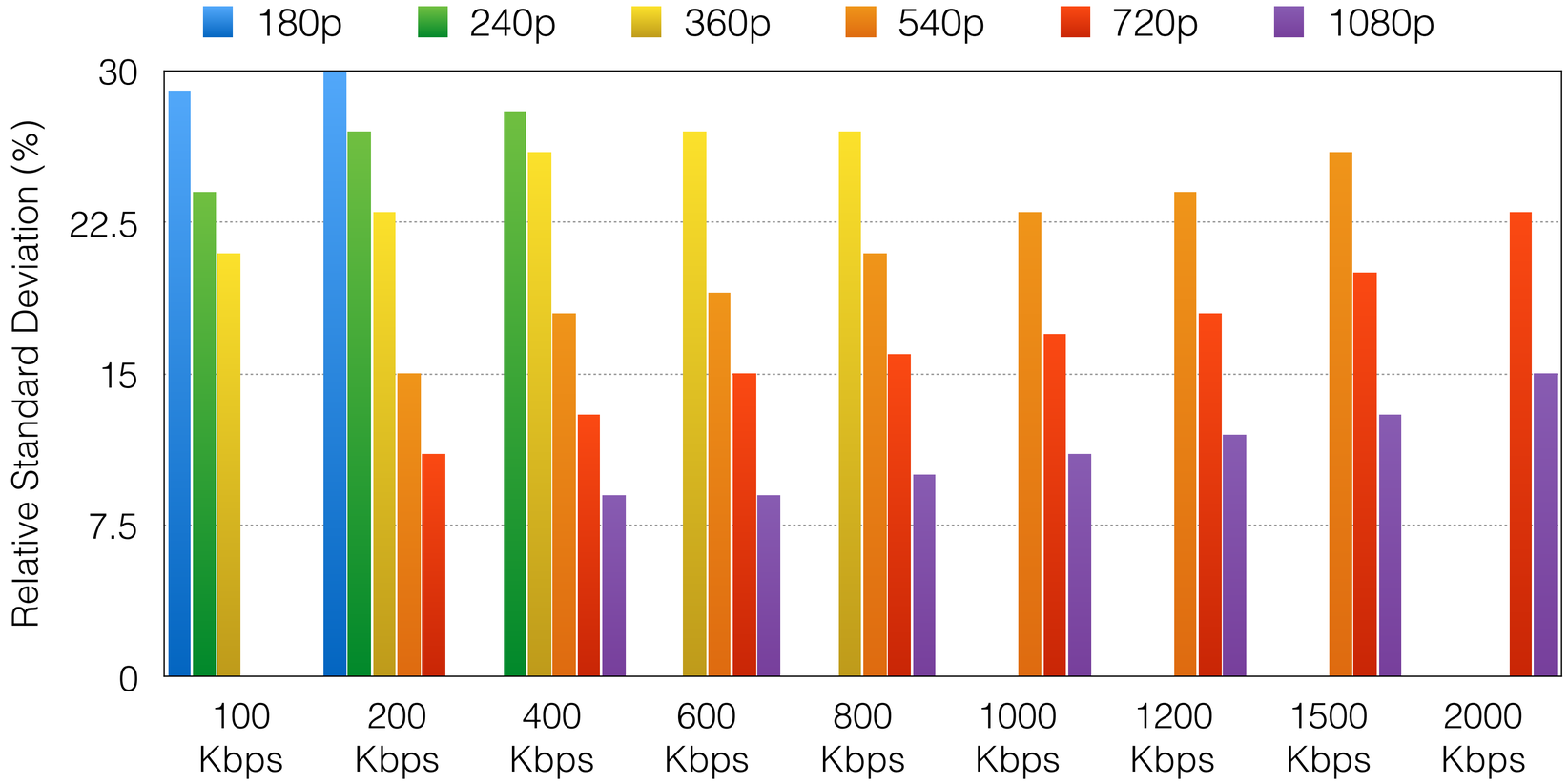



**Ratio of Actual vs. Target Rate**

| % | 100 Kbps | 200 Kbps | 400 Kbps | 600 Kbps | 800 Kbps | 1000 Kbps | 1200 Kbps | 1500 Kbps | 2000 Kbps |
|---|---|---|---|---|---|---|---|---|---|
| **90p** | 59 | 37 | 19 | 13 | 10 | 8 | 6 | 5 | 4 |
| **180p** | 84 | 76 | 56 | 40 | 30 | 24 | 20 | 16 | 12 |
| **240p** | 91 | 84 | 71 | 56 | 44 | 36 | 30 | 24 | 18 |
| **360p** | 96 | 89 | 84 | 77 | 68 | 59 | 51 | 42 | 32 |
| **540p** | | 99 | 98 | 96 | 93 | 89 | 85 | 77 | 64 |
| **720p** | | 100 | 100 | 99 | 99 | 98 | 96 | 93 | 87 |
| **1080p** | | | 101 | 101 | 101 | 101 | 100 | 100 | 99 |

<50% 50-75% 75-100%

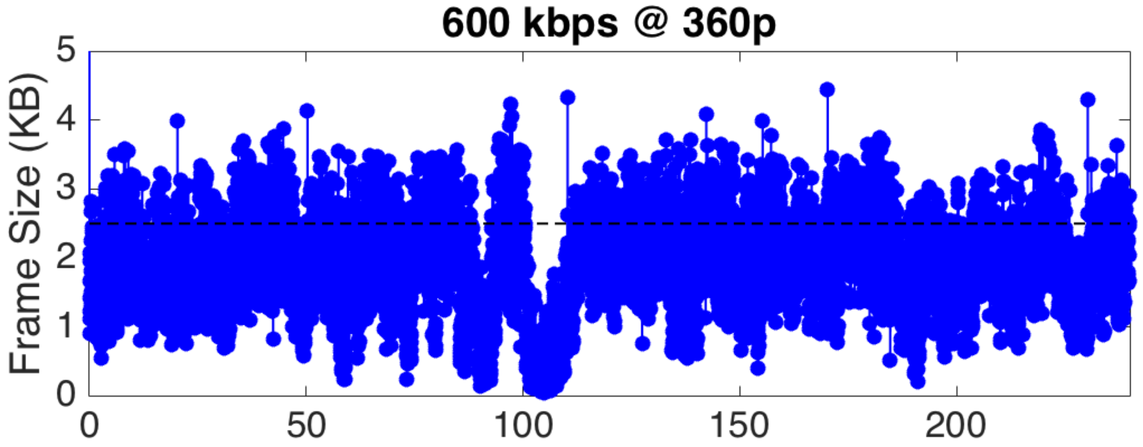
# Overview of Steady-State Traces:  Relative Rate Variations

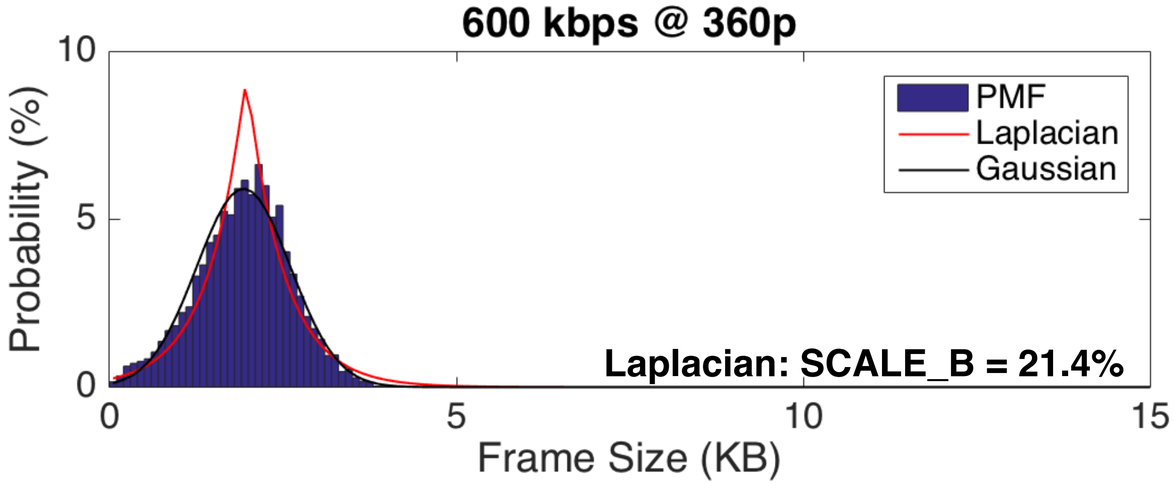


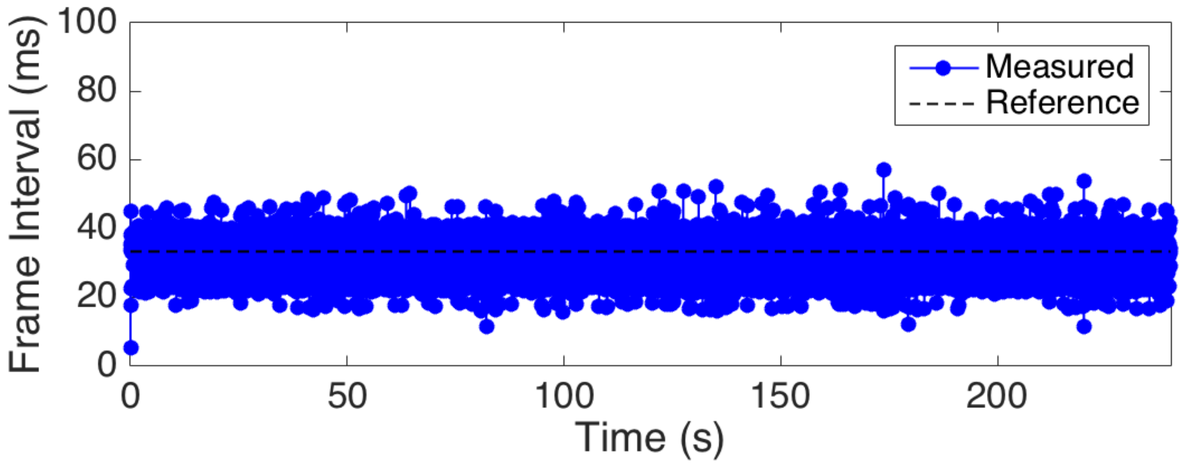

Observations:

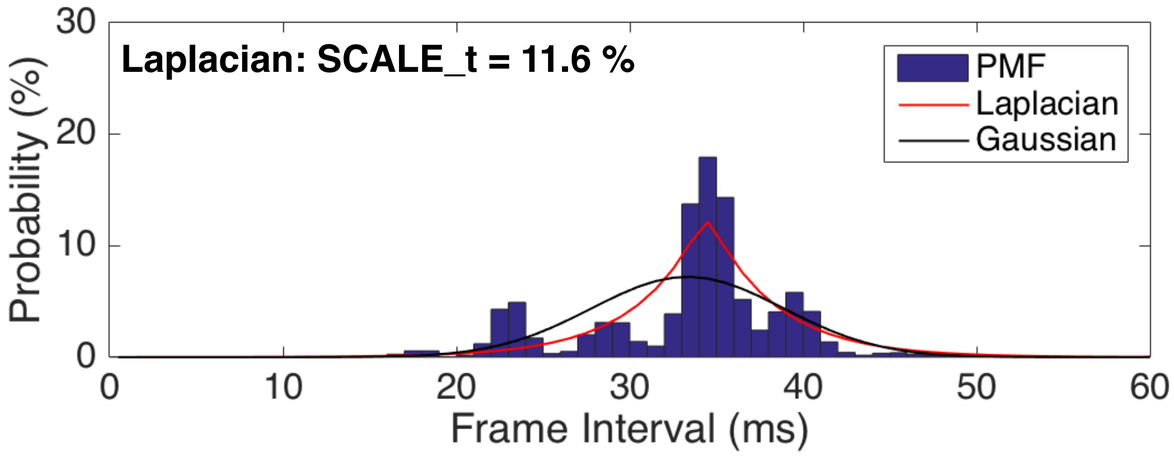
- For a given rate, relative rate variation ***decreases with higher resolutions;***
- For a given resolution, relative rate variation ***increases with higher rates***

# Example Trace and Histogram: 600 Kbps @ 360p

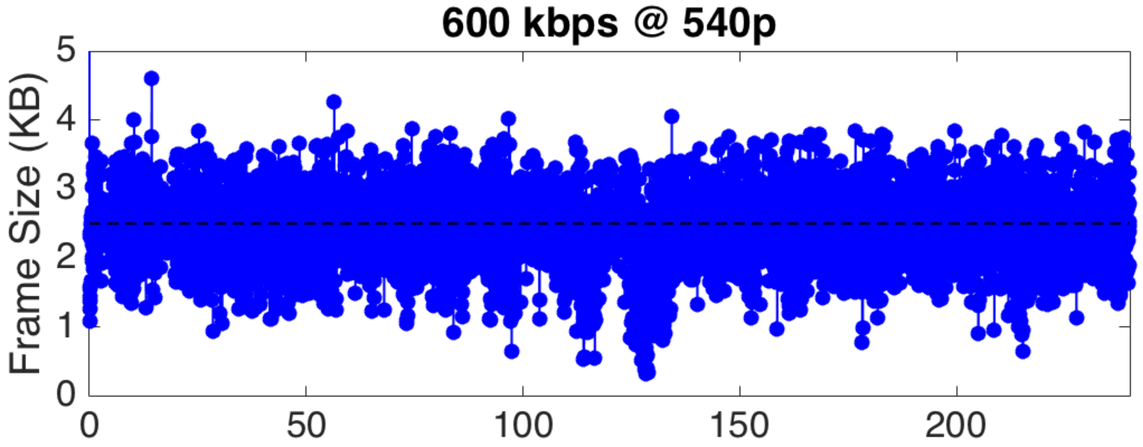


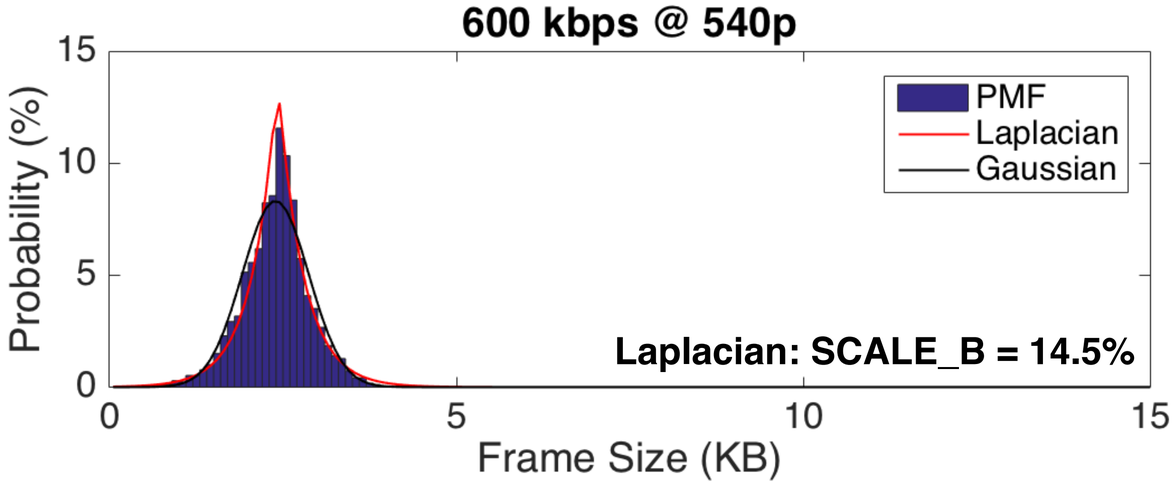



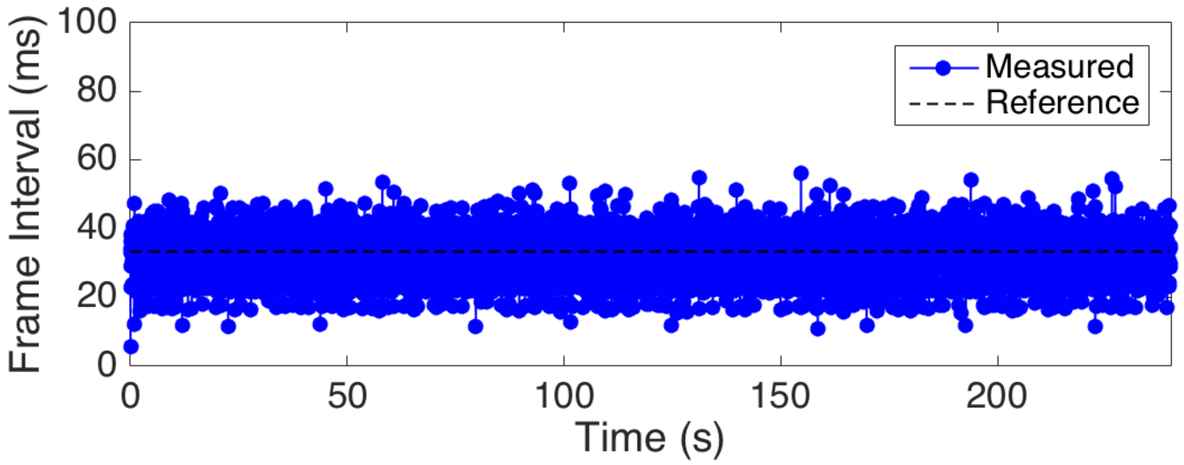



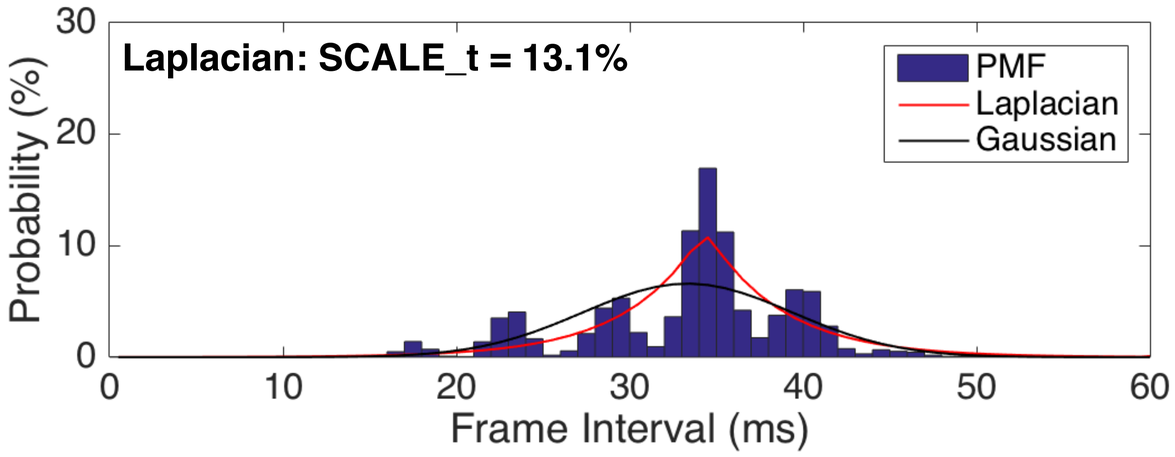



# ExampleTrace and Histogram: 600 Kbps @ 540p

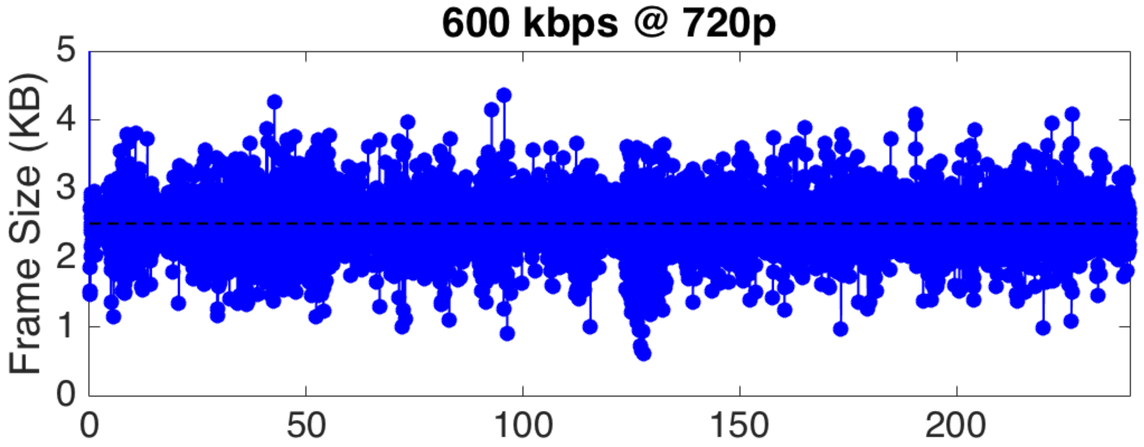


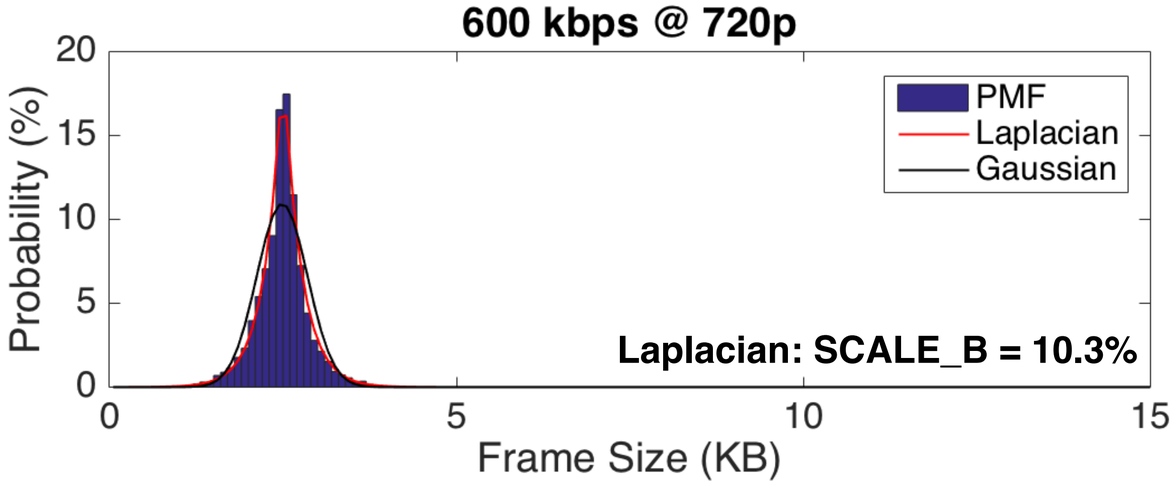



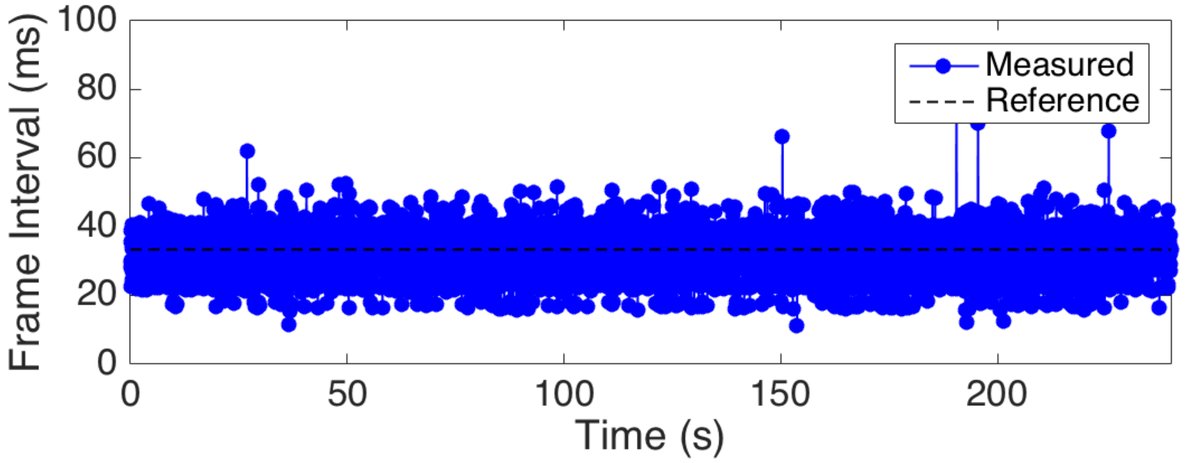



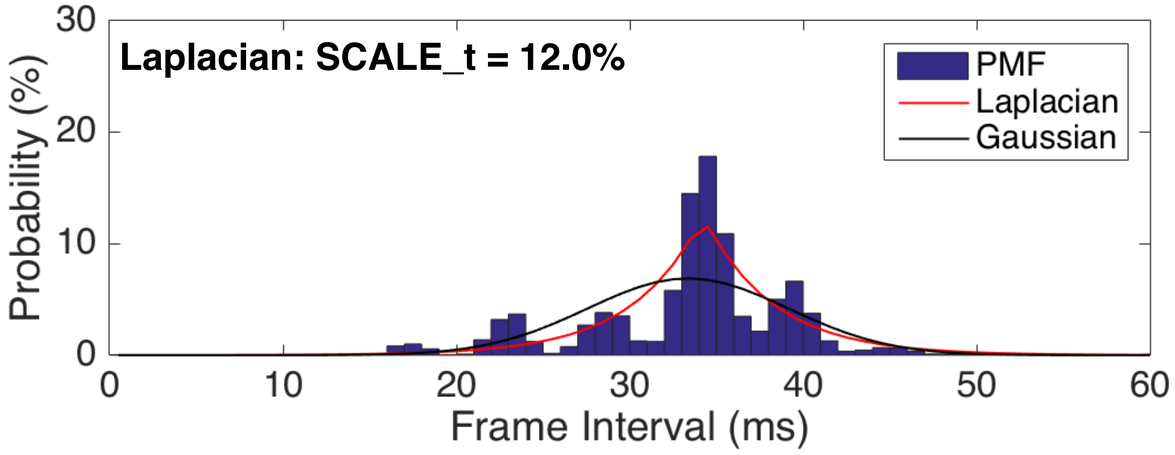



# Example Trace and Histogram: 600 Kbps @ 720p

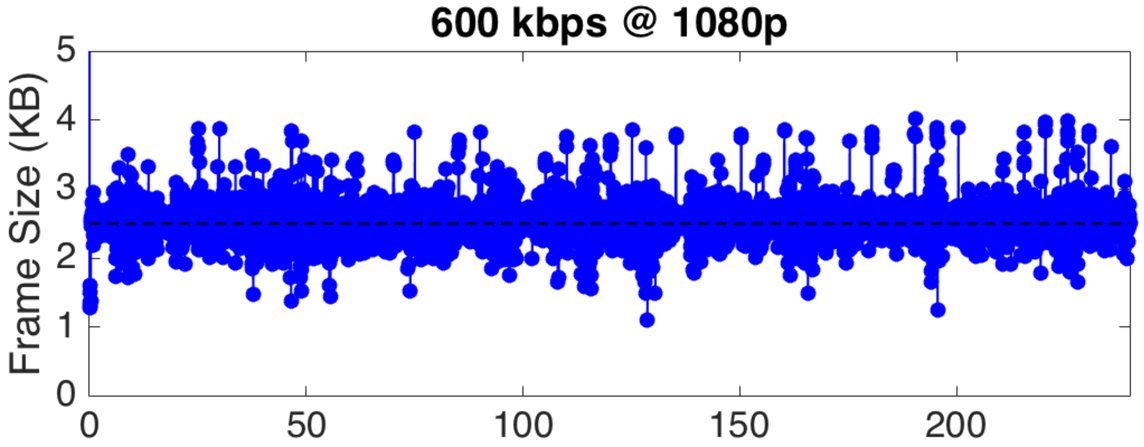


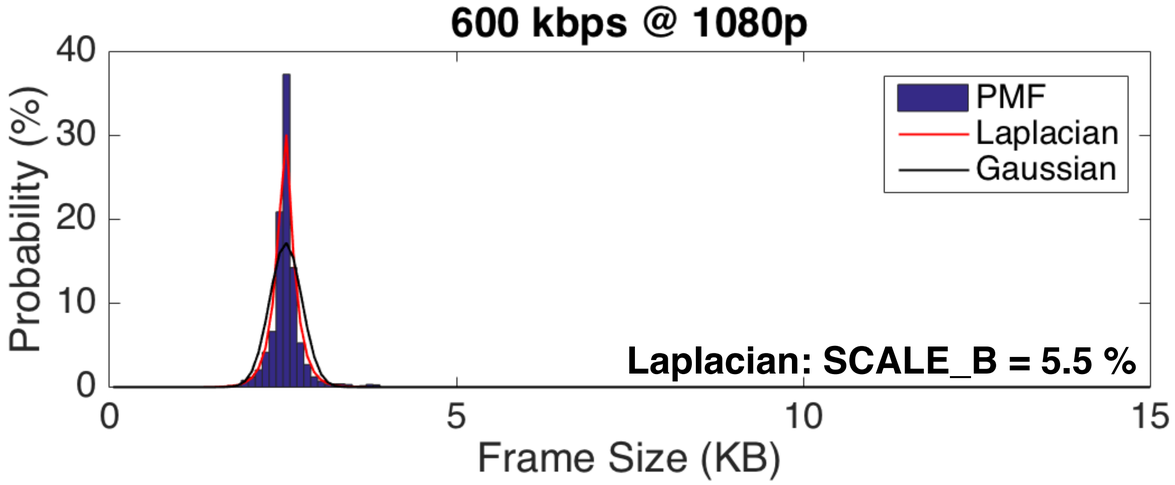



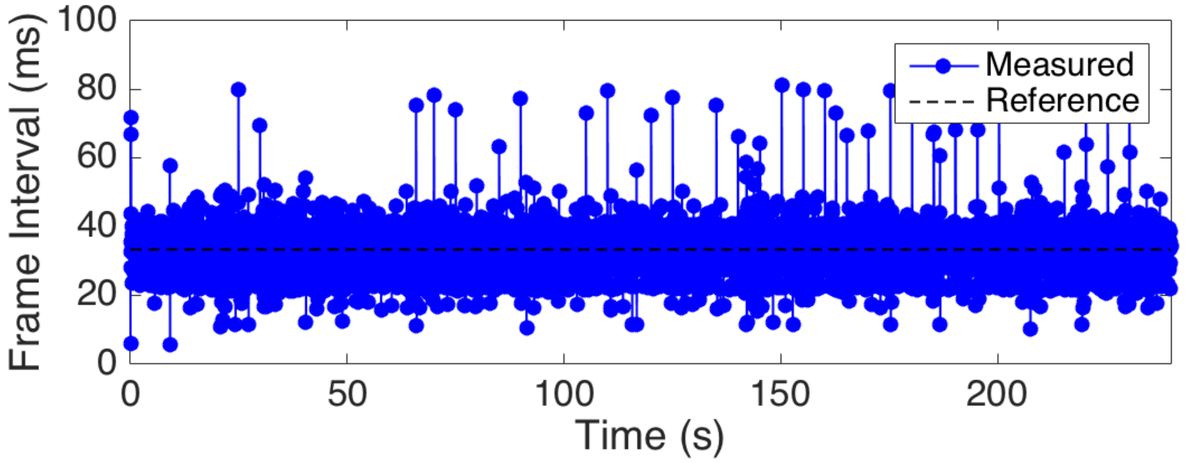



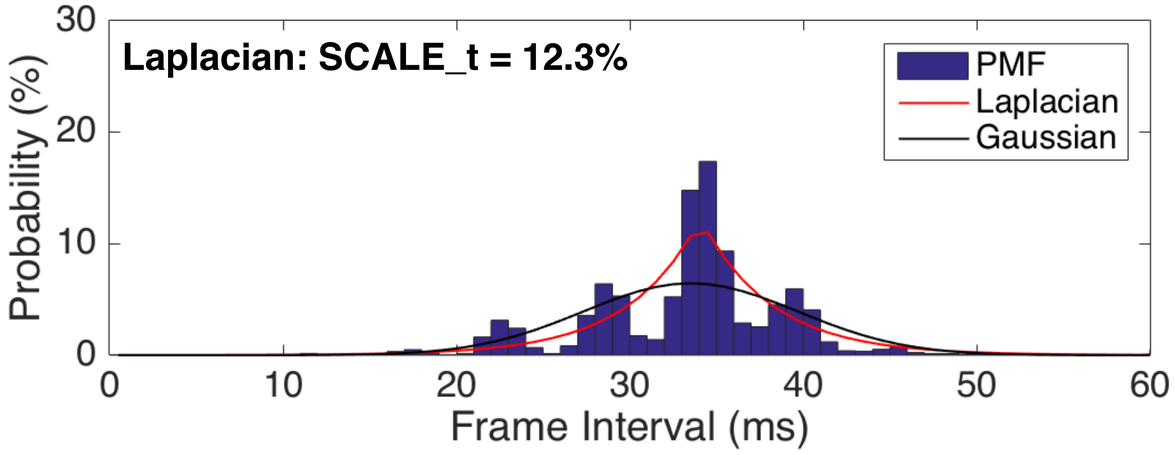



# Example Trace and Histogram: 600 Kbps @ 1080p



# Laplace Distribution of Frame Size and Intervals

**SCALE_B for Frame Size Distributions**

| % | 100 Kbps | 200 Kbps | 400 Kbps | 600 Kbps | 800 Kbps | 1000 Kbps | 1200 Kbps | 1500 Kbps | 2000 Kbps |
|---|---|---|---|---|---|---|---|---|---|
| 90p | | | | | | | | | |
| 180p | 22 | 23 | | | | | | | |
| 240p | 18 | 21 | | | | | | | |
| 360p | 16 | 18 | 20 | 21 | | | | | |
| 540p | | 11 | 13 | 14 | 16 | 17 | 19 | 21 | |
| 720p | | 7 | 9 | 10 | 11 | 12 | 13 | 15 | 18 |
| 1080p | | | 5 | 5 | 6 | 7 | 8 | 9 | 10 |

**Range of values: 5-23%**

**SCALE_t for Frame Interval Distributions**

| % | 100 Kbps | 200 Kbps | 400 Kbps | 600 Kbps | 800 Kbps | 1000 Kbps | 1200 Kbps | 1500 Kbps | 2000 Kbps |
|---|---|---|---|---|---|---|---|---|---|
| 90p | | | | | | | | | |
| 180p | 10 | 10 | | | | | | | |
| 240p | 11 | 10 | | | | | | | |
| 360p | 11 | 11 | 11 | 12 | | | | | |
| 540p | | 12 | 12 | 13 | 14 | 14 | 14 | 14 | |
| 720p | | 11 | 11 | 12 | 13 | 15 | 15 | 15 | 16 |
| 1080p | | | 13 | 12 | 14 | 15 | 17 | 20 | 15 |

**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:
  - t0 — reference interval determined by average frame rate: 1/FPS
  - SCALE_t — scaling parameter of normalized frame interval (t/t0): 10-20%  [Default: 15%]
- Laplace distribution of steady-state frame sizes
  - B0 — reference frame size determined by target rate and frame rate: R/8/FPS
  - SCALE_B — scaling parameter of normalized frame size  (B/B0): 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