Update on NADA

draft-ietf-rmcat-nada-01

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2015-11-05

Outline

- Update on draft and algorithm
- Update on evaluation results in NS2 (wired test case and AQMs)
- Additional test results:
  - NADA evaluation in NS3
  - Impact of rate update parameters
- Open Issues and next steps

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Overview of Changes in Draft -01

- Algorithm change: revised equation for gradual rate update (more details to follow)
- Structure change:
    - NADA congestion control algorithm in Sec. 4
    - Recommended practical implementation in Sec. 5
    - All discussions on open issues in Sec. 7
- More clear descriptions:
    - List of all variables and parameters in Sec. 4.1
    - Receiver procedure in Sec 5.1: 15-tap minimum filter for queuing delay estimation
    - Rate shaping behavior in Sec 5.2 as recommended (optional) feature

List of Notations for Gradual Rate Update

Input/Algorithm Parameters:

$PRIO$: weight of priority of the flow

$RMAX$: maximum rate of the flow

$RMIN$: minimum rate of the flow

$XREF$: reference value of aggregated congestion signal

κ, η : scaling parameters for gradual rate update calculation

τ : upper bound of RTT in gradual rate update calculation

Variables:

r_n : reference rate based on network congestion control

x_n : reported aggregated congestion level

x_{prev} : previous value of aggregated congestion level

δ : observed interval between current and previous feedback report

See full list of notations in the updated draft

Revised Equation for Gradual Rate Update

Calculate offset and change in aggregate congestion signal x_n:

$$x_{offset} = x_n - PRIO * XREF * \frac{RMAX}{r_n}$$

$$x_{diff} = x_n - x_{prev}$$

Update rate in proportion to both offset and change in x_n:

$$r_n = r_n - \kappa \frac{\delta}{\tau} \frac{x_{offset}}{\tau} r_n - \kappa \eta \frac{x_{diff}}{\tau} r_n$$

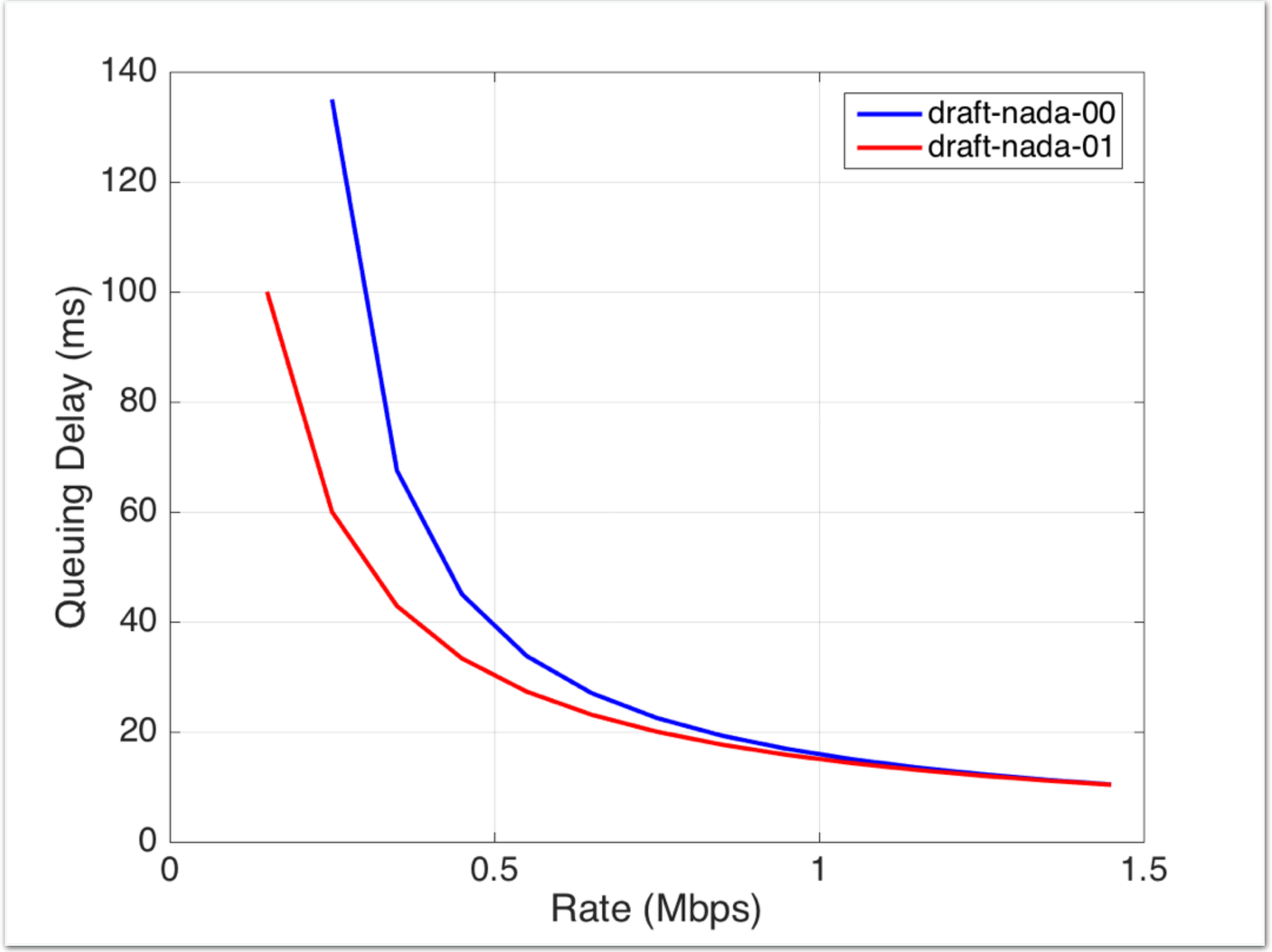
Tradeoff Between Rate and Queuing Delay at Equilibrium

Old Version:

$$x_{eq} = PRIO * XREF * \frac{RMAX - RMIN}{r_{eq} - RMIN}$$

New Version:

$$x_{eq} = PRIO * XREF * \frac{RMAX}{r_{eq}}$$



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Updated Eval Results on RMCAT Test Cases in NS2

- **5.1 Variable Available Capacity with Single RMCAT flow**
  - ***5.1.a: Low Available Capacity with UDP Background Traffic***
- **5.2. Variable Available Capacity with Multiple RMCAT flows**
- 5.3. Congested Feedback Link with Bi-directional RMCAT flows
  - *5.3.a: Congested Feedback Link with TCP Flow along Backward Path*
- **5.4. Competing Flows with Same RMCAT Algorithm**
- **5.5. Round Trip Time Fairness**
- **5.6. RMCAT Flow Competing with a Long TCP Flow**
- 5.7. RMCAT Flow Competing with Short TCP Flows
- 5.8. Media Pause and Resume

5.1 Variable Available Capacity with Single RMCAT Flow

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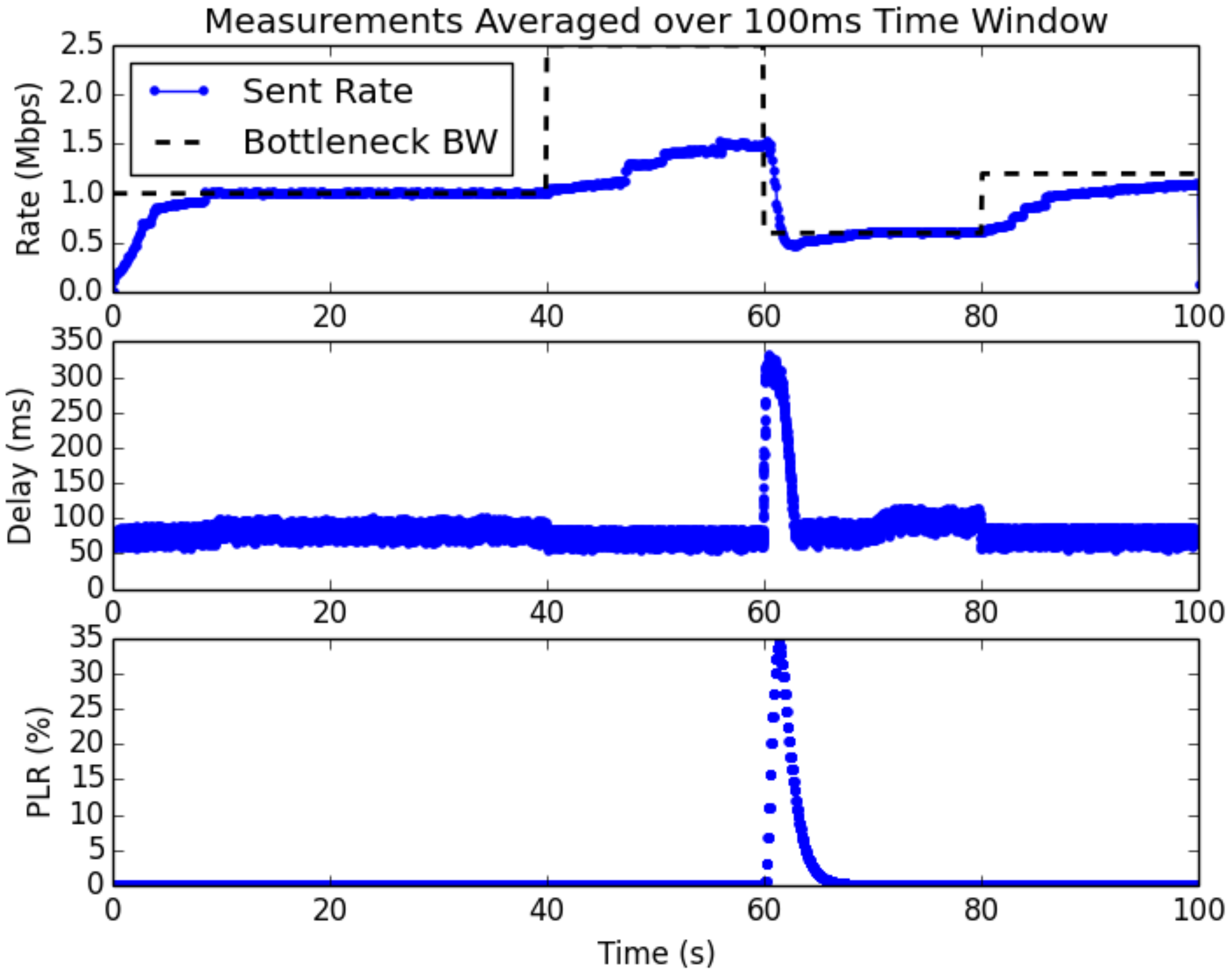

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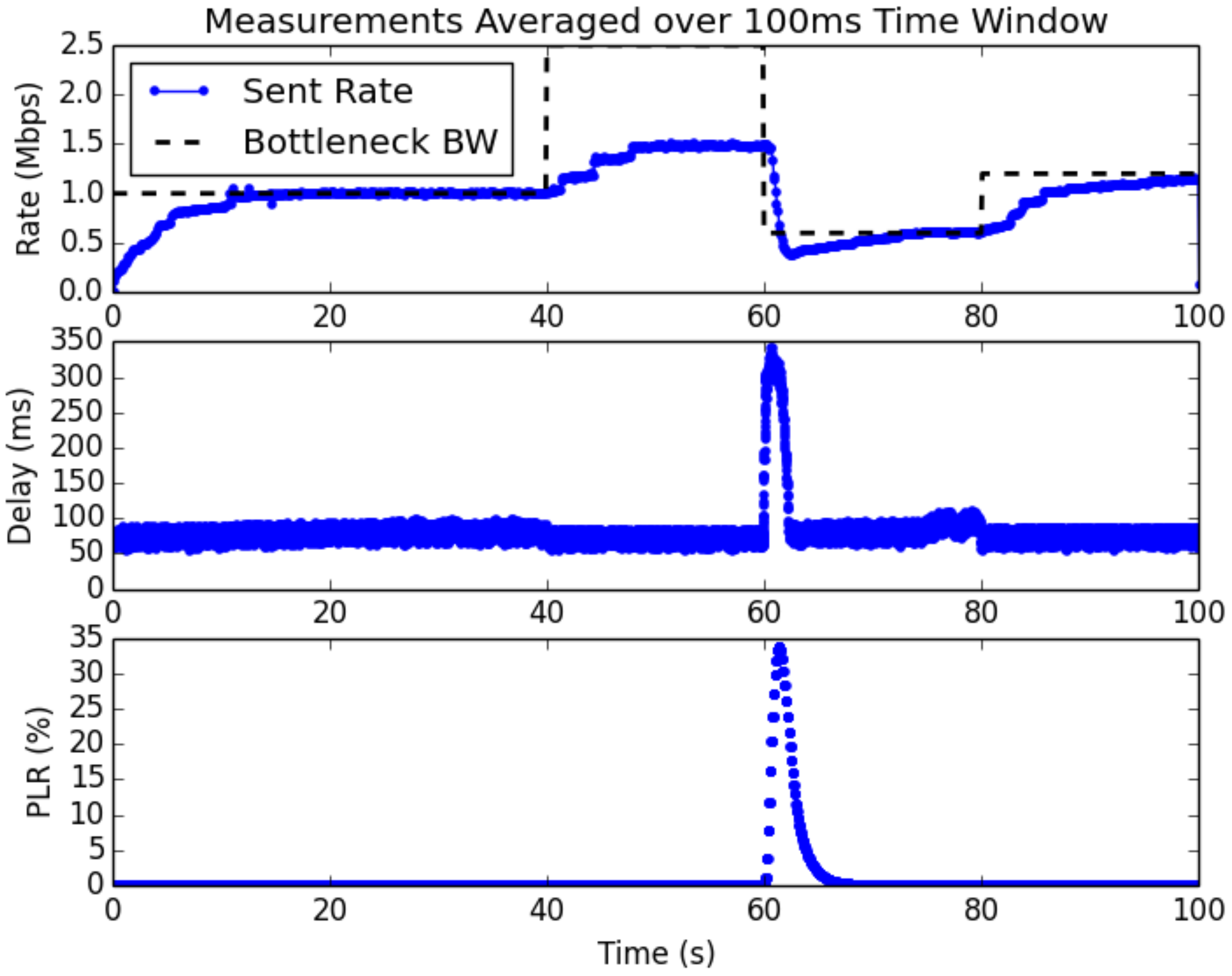

5.1.a: Low Available Capacity with UDP Background Traffic

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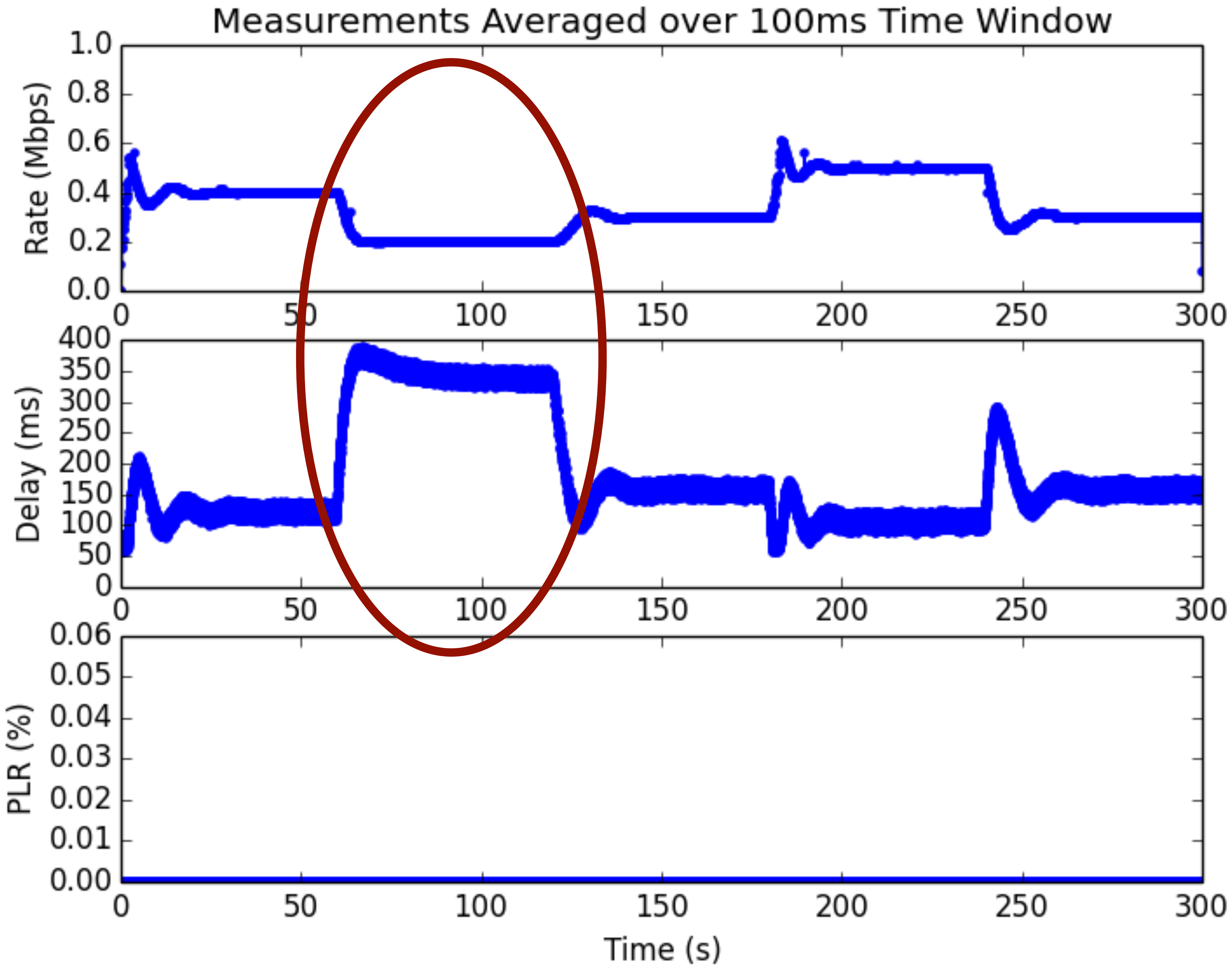

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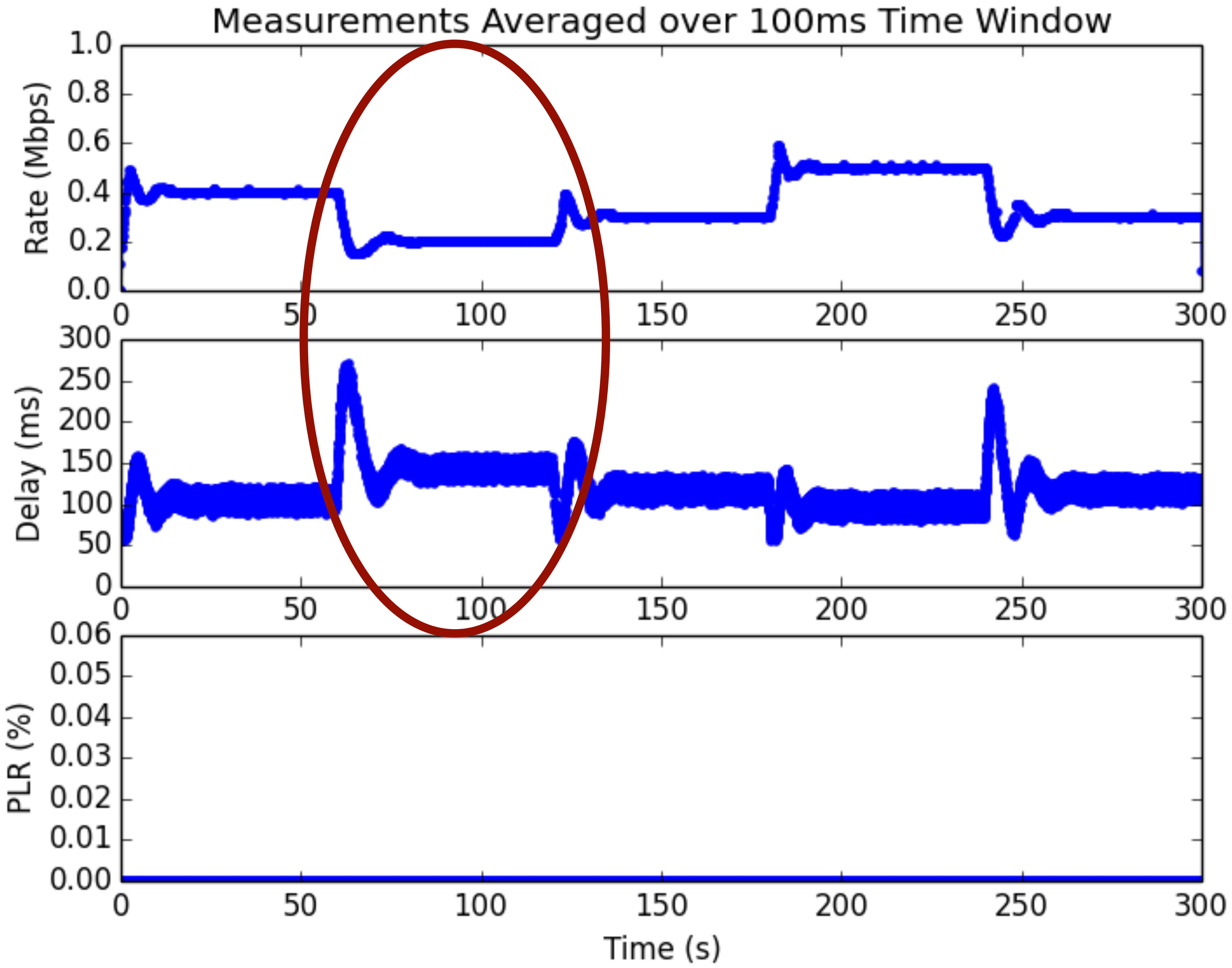

5.2 Variable Available Capacity with Multiple RMCAT Flows

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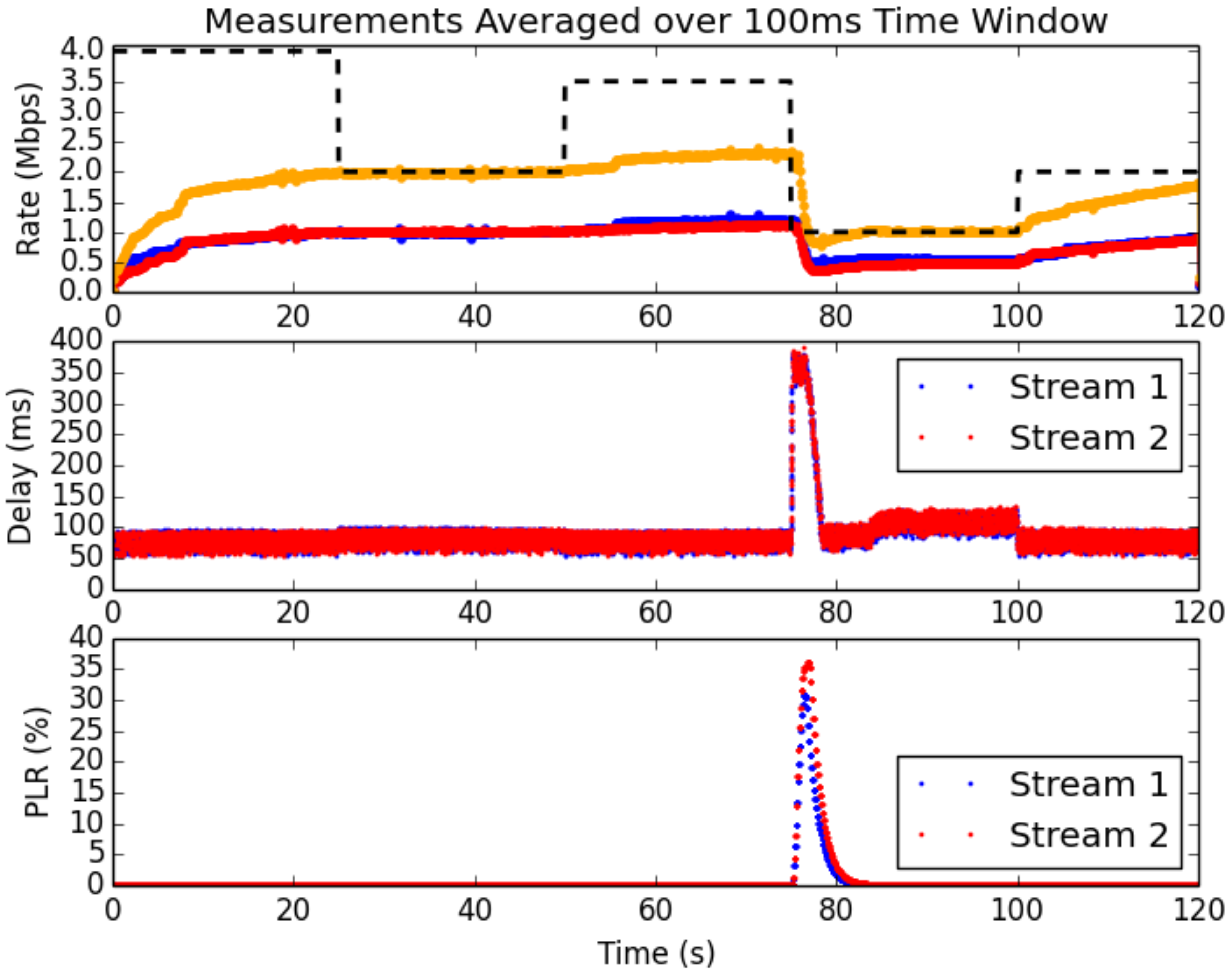

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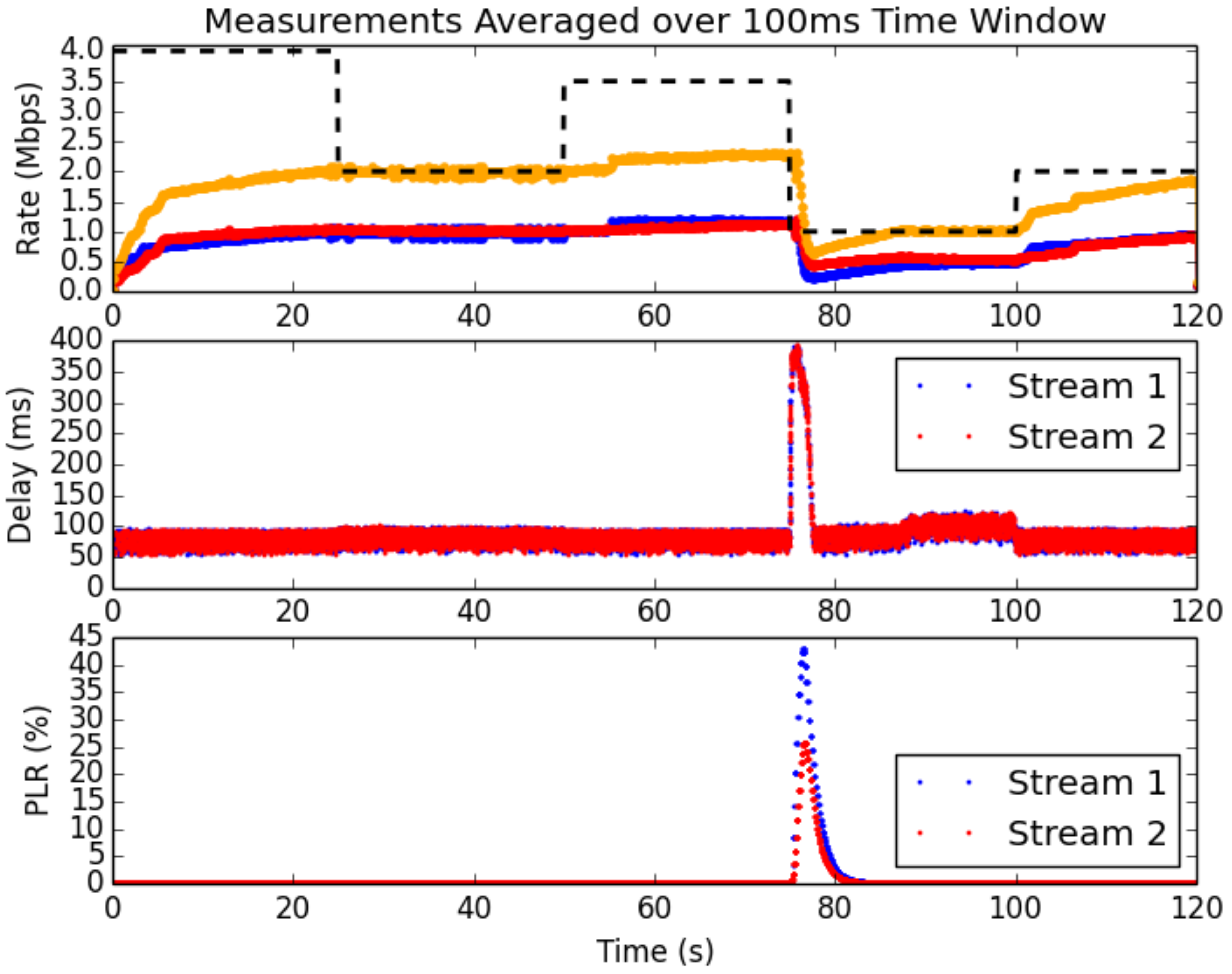

5.4. Competing Flows with Same RMCAT Algorithm

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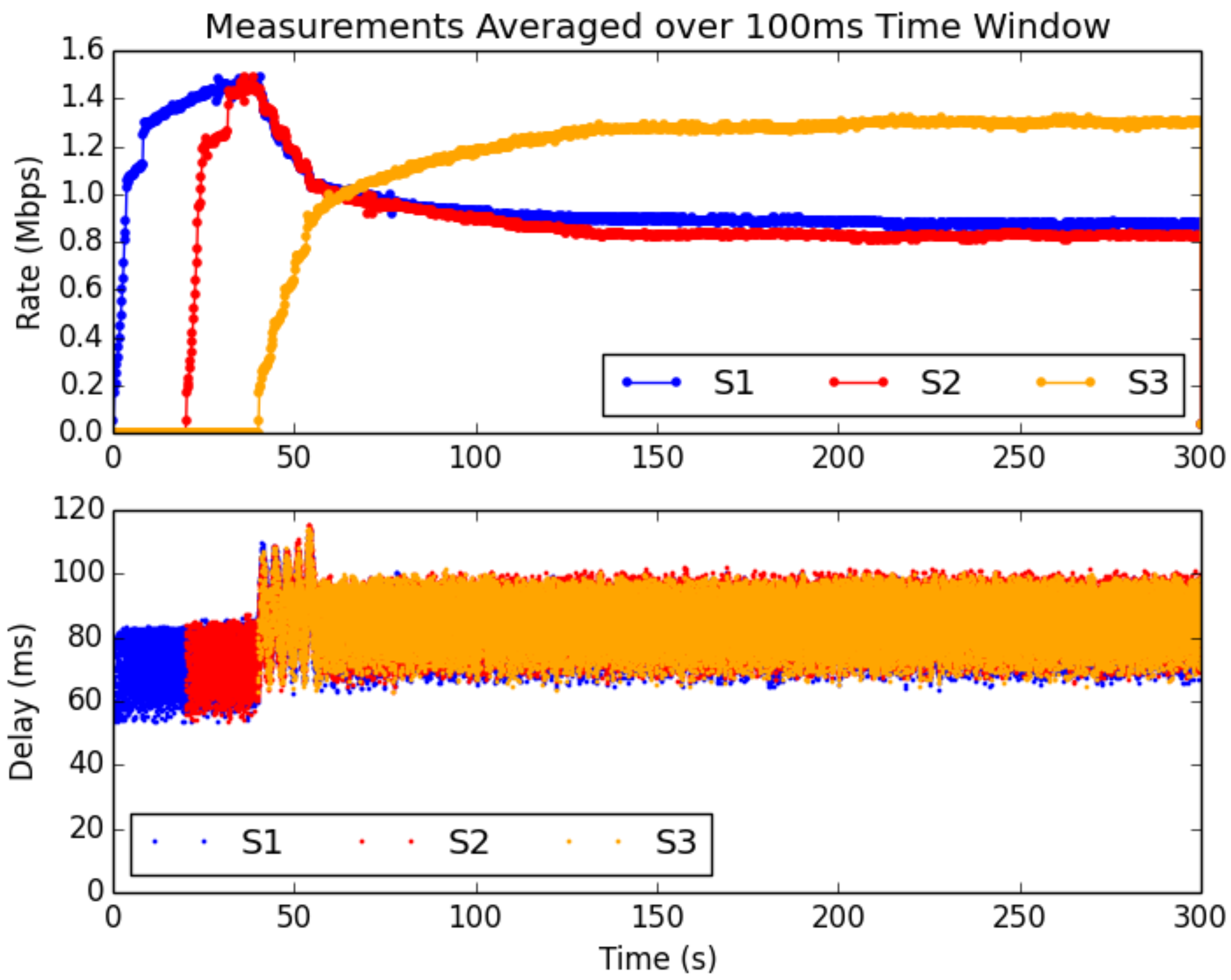

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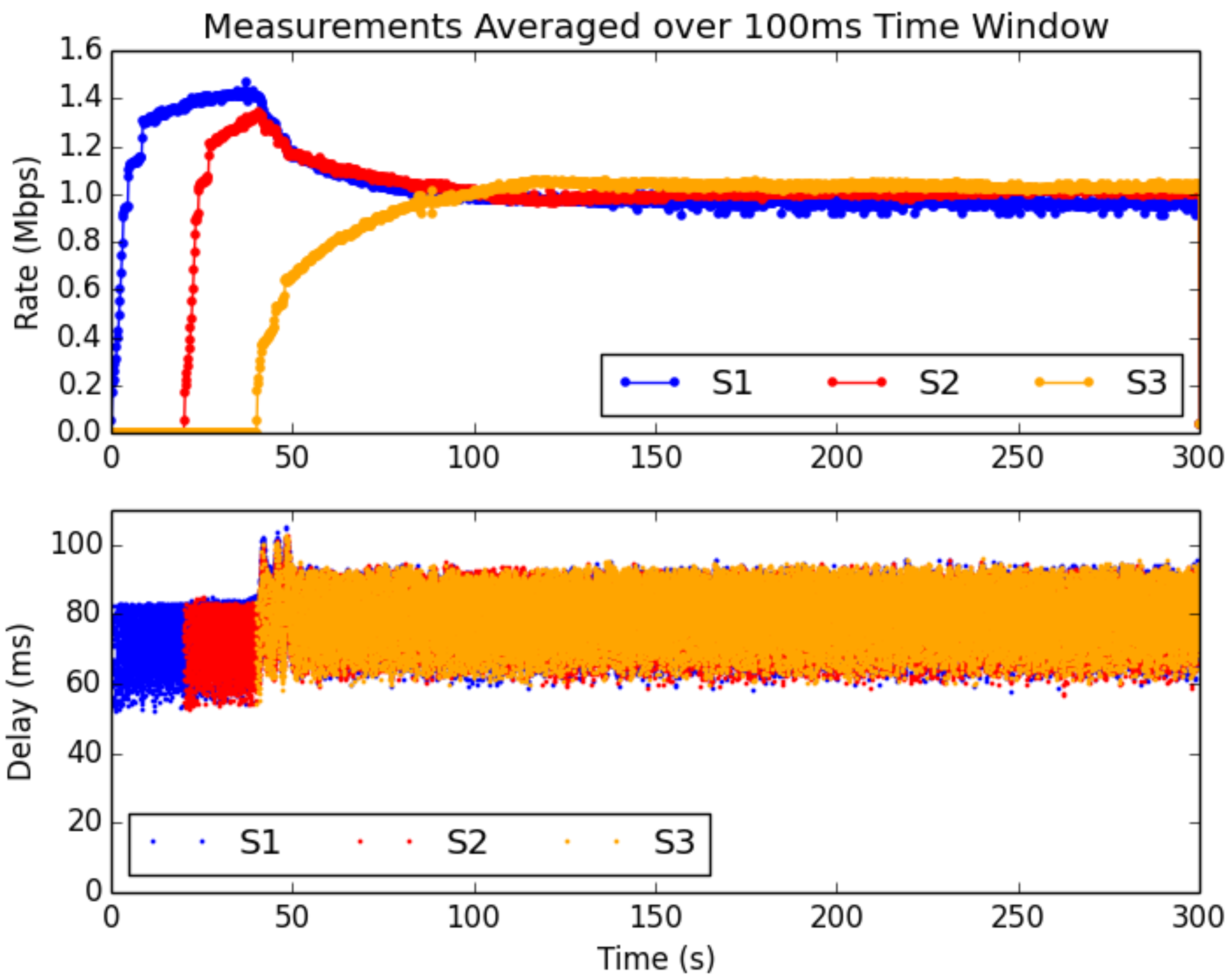

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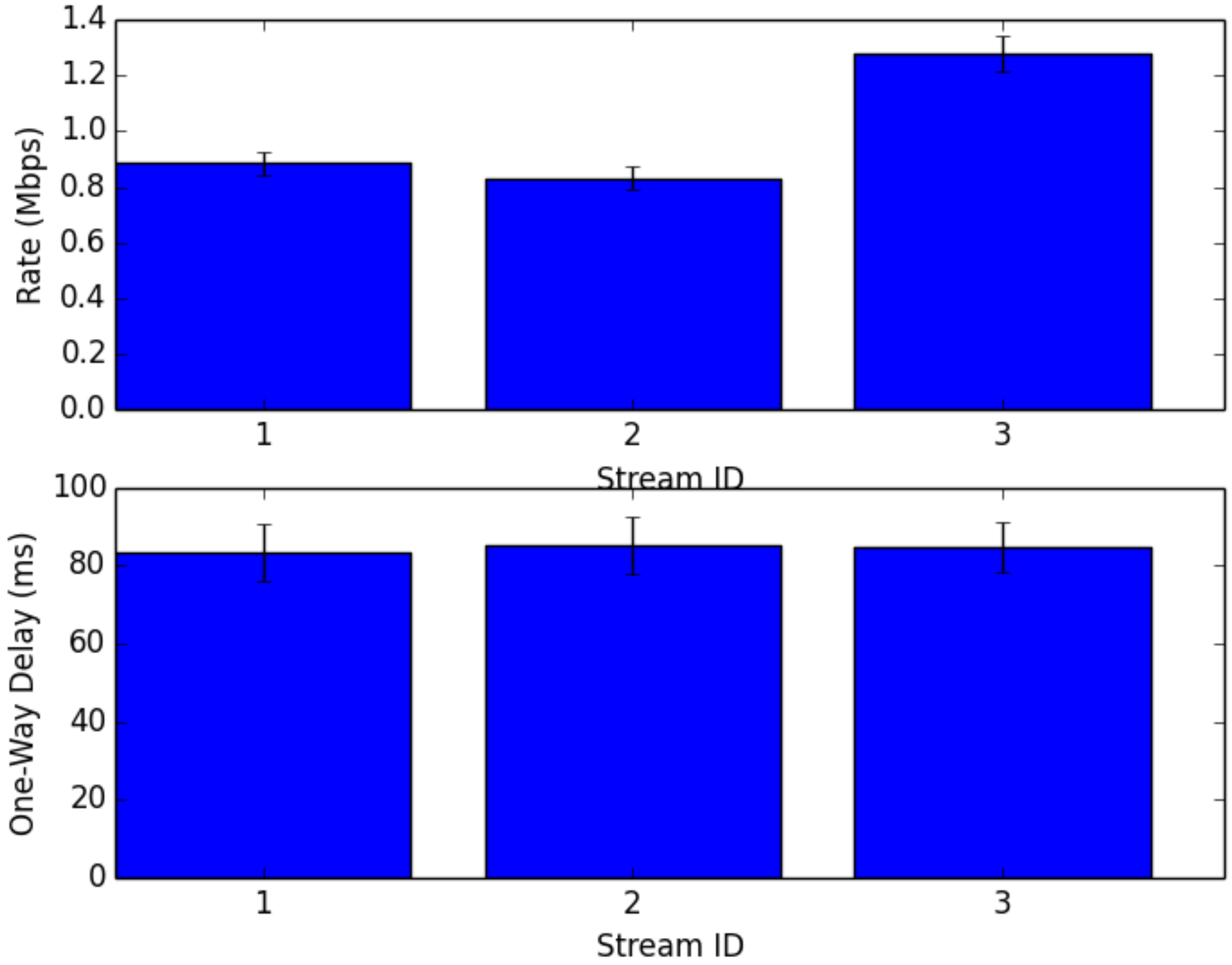

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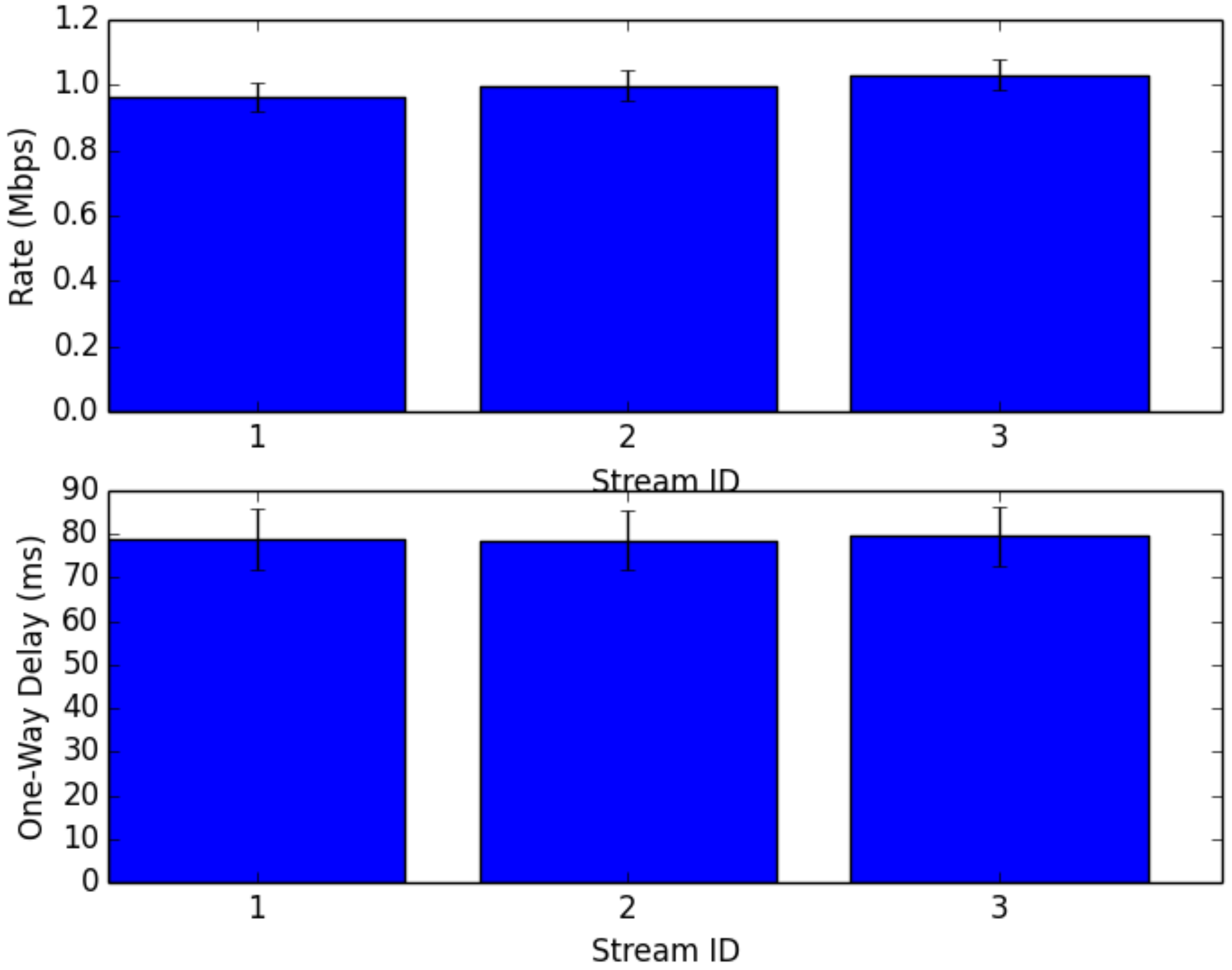

5.5. Round Trip Time Fairness

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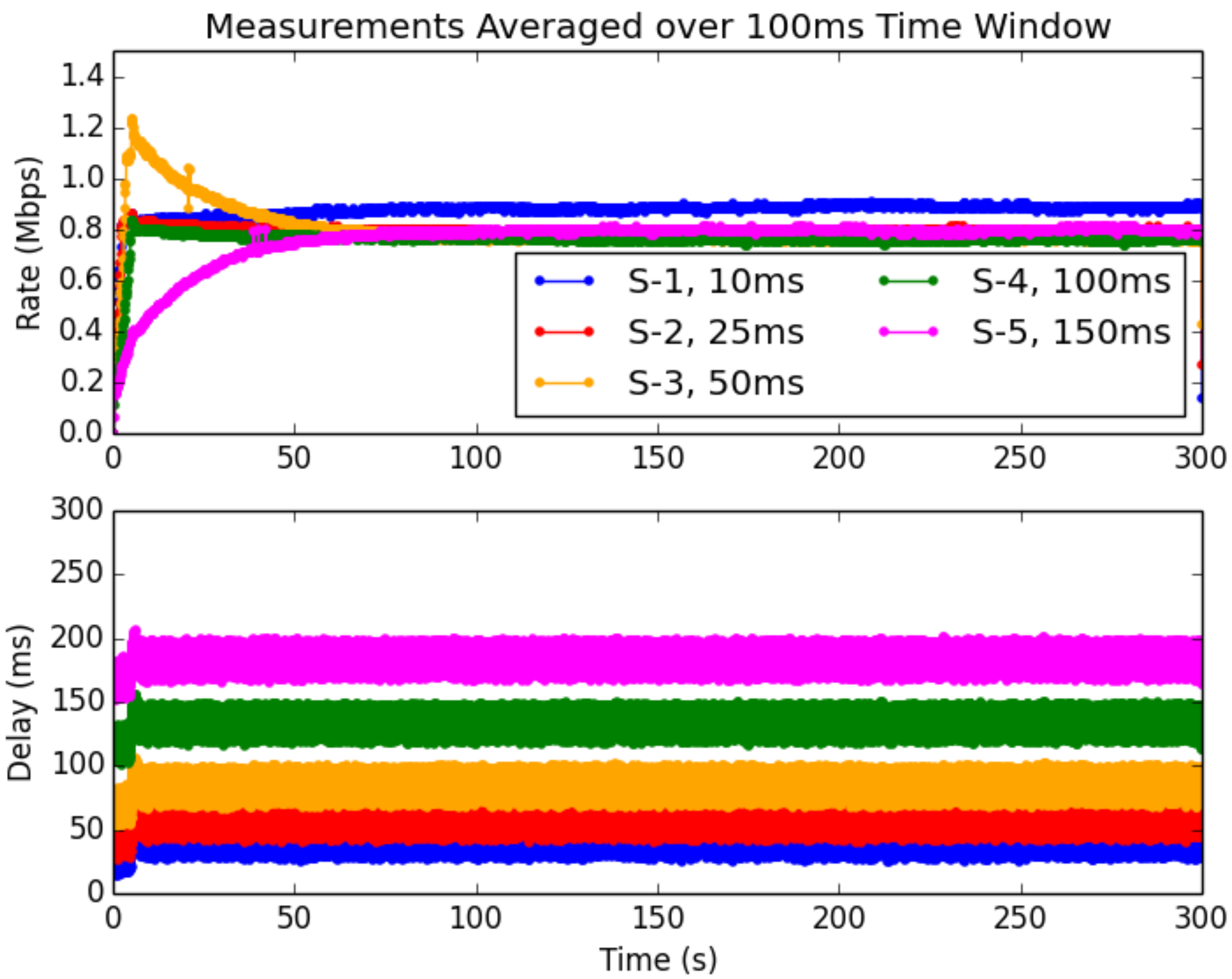

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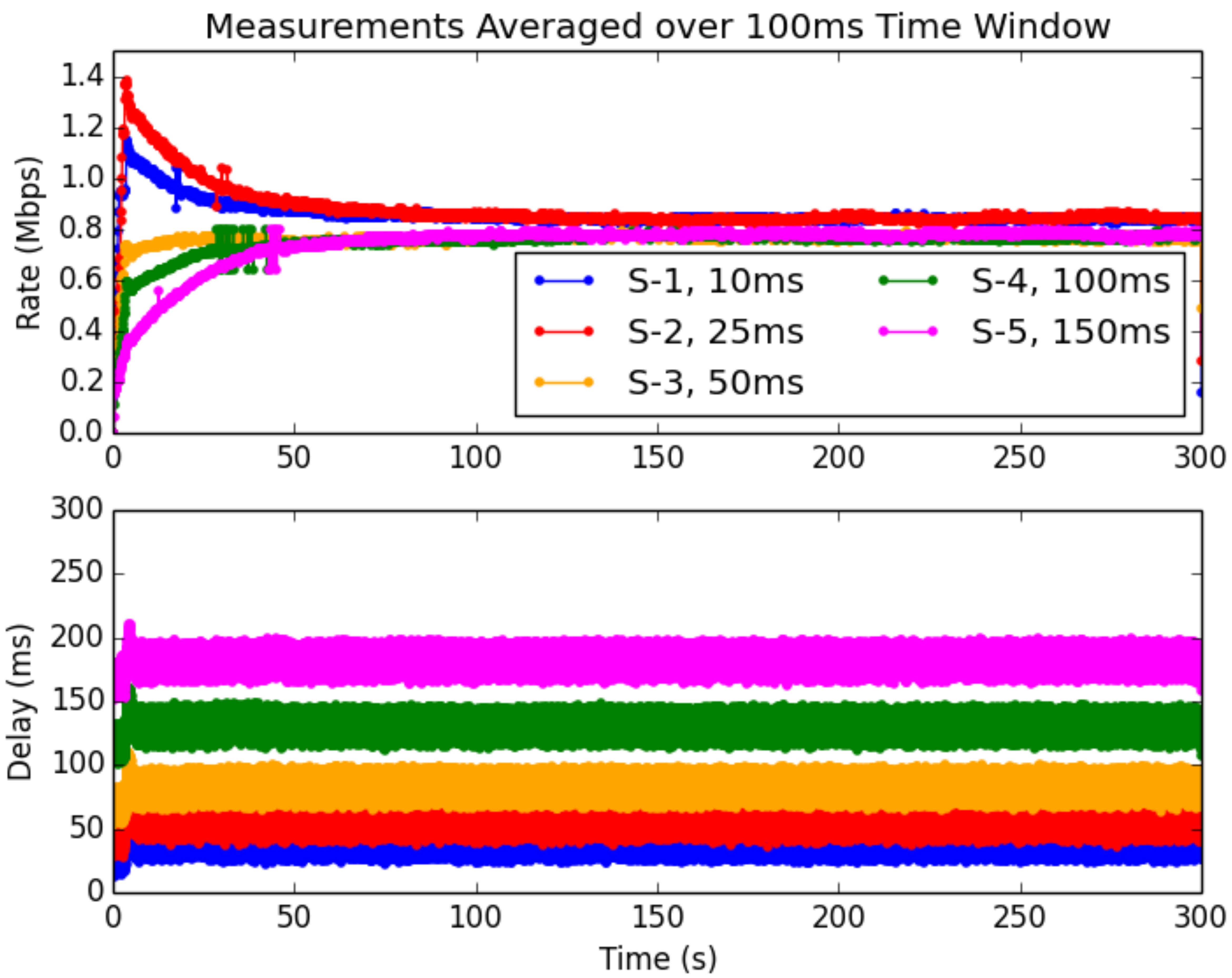

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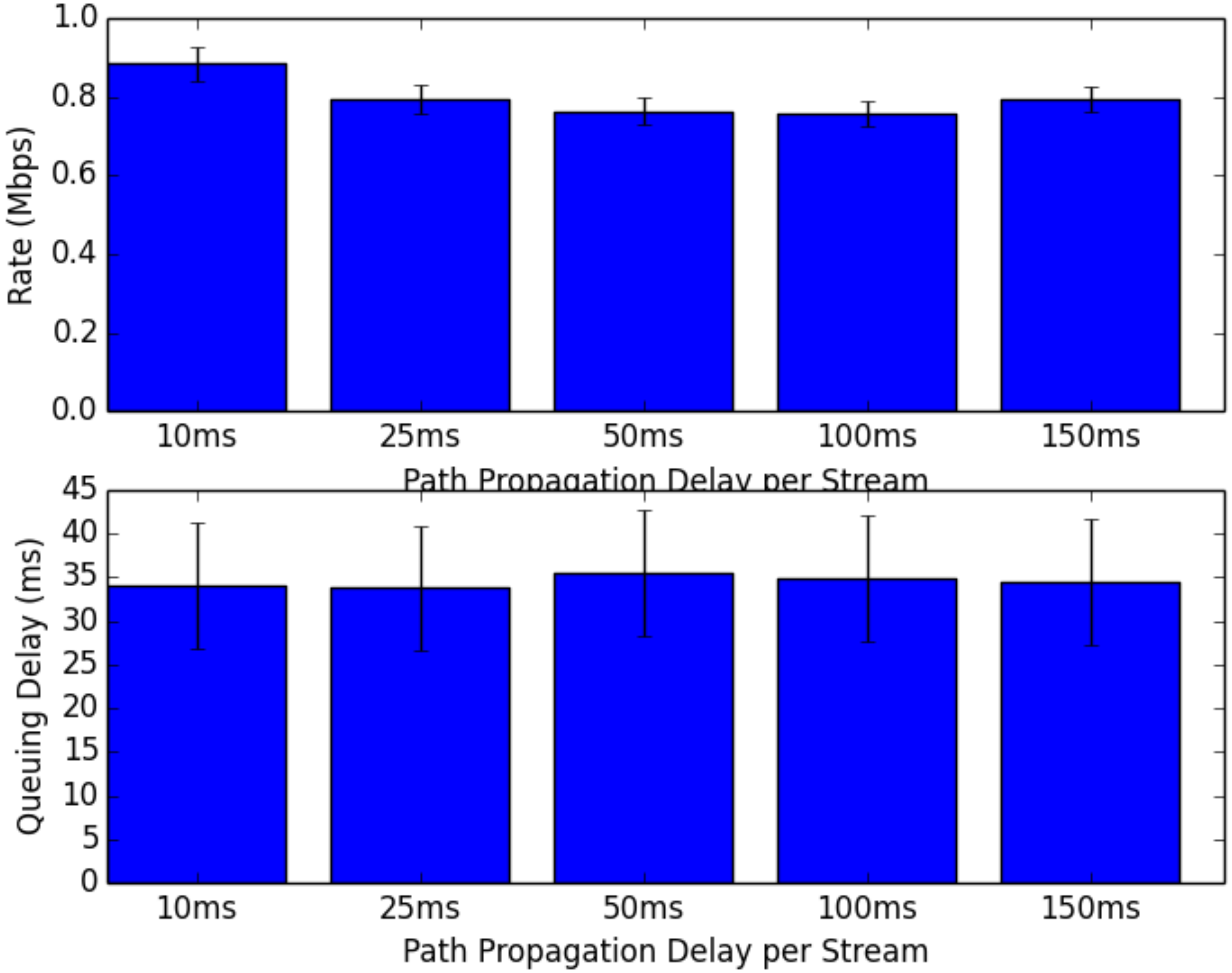

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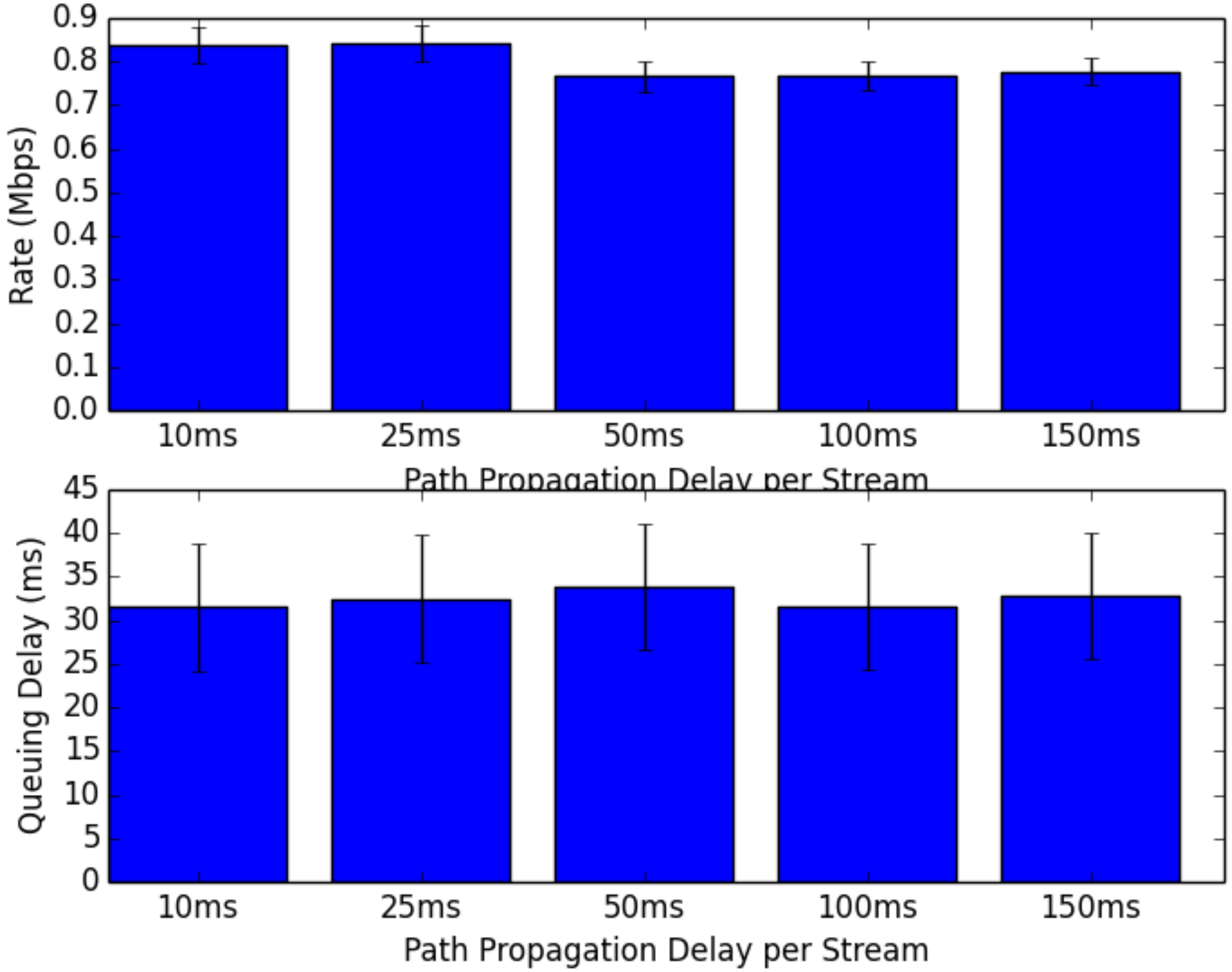

5.6. RMCAT Flow Competing with a Long TCP Flow

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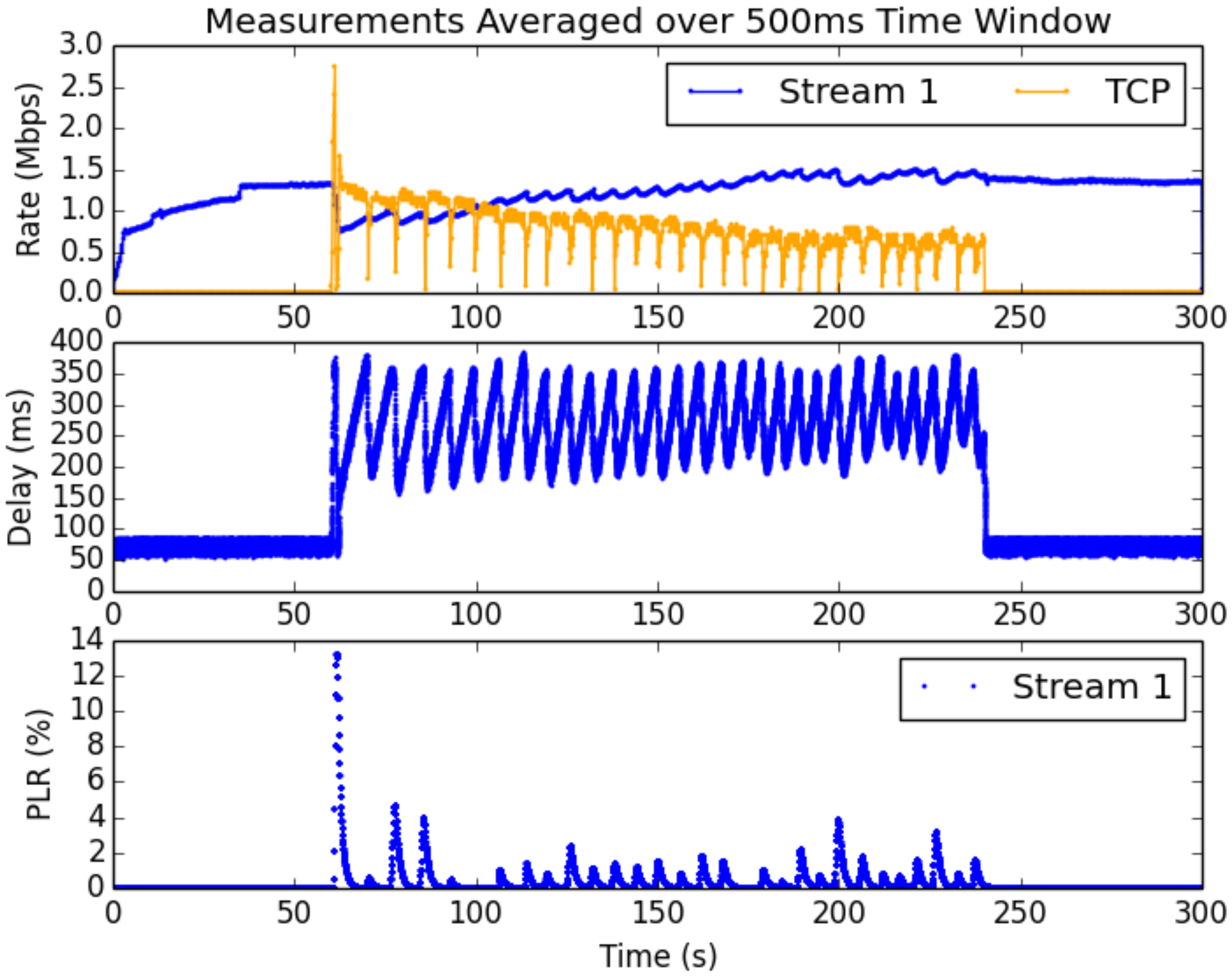

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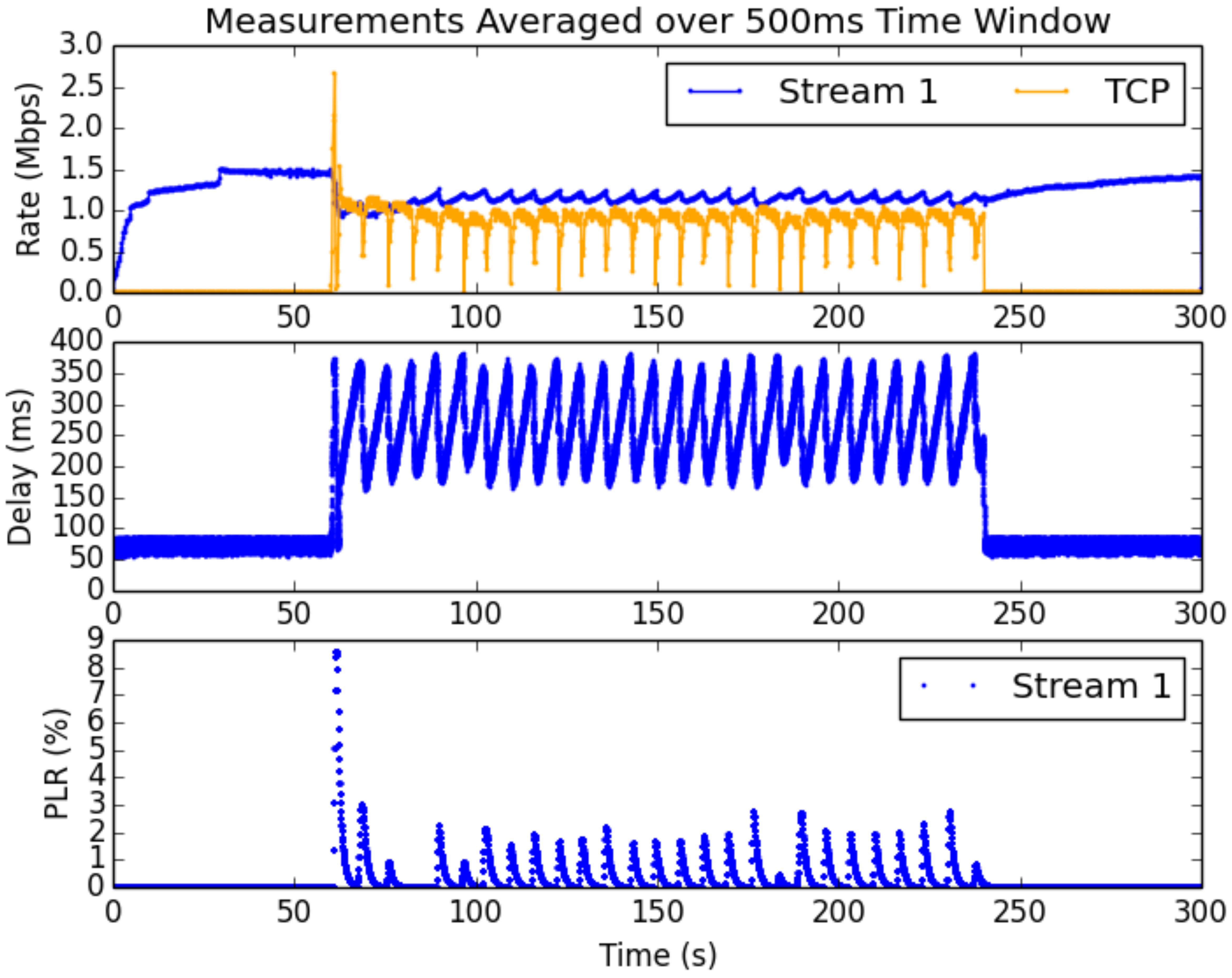

NADA Interaction with AQM: RED

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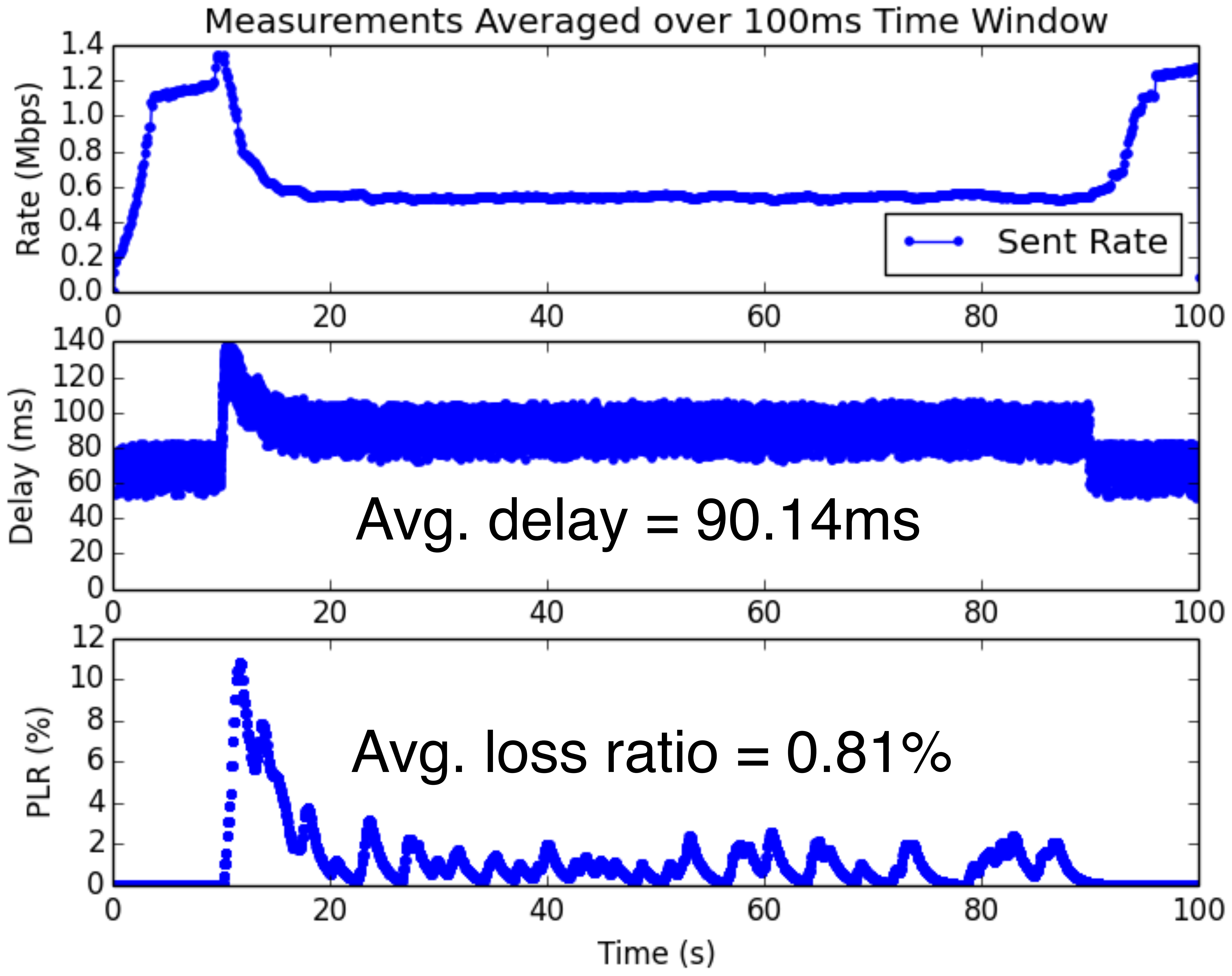

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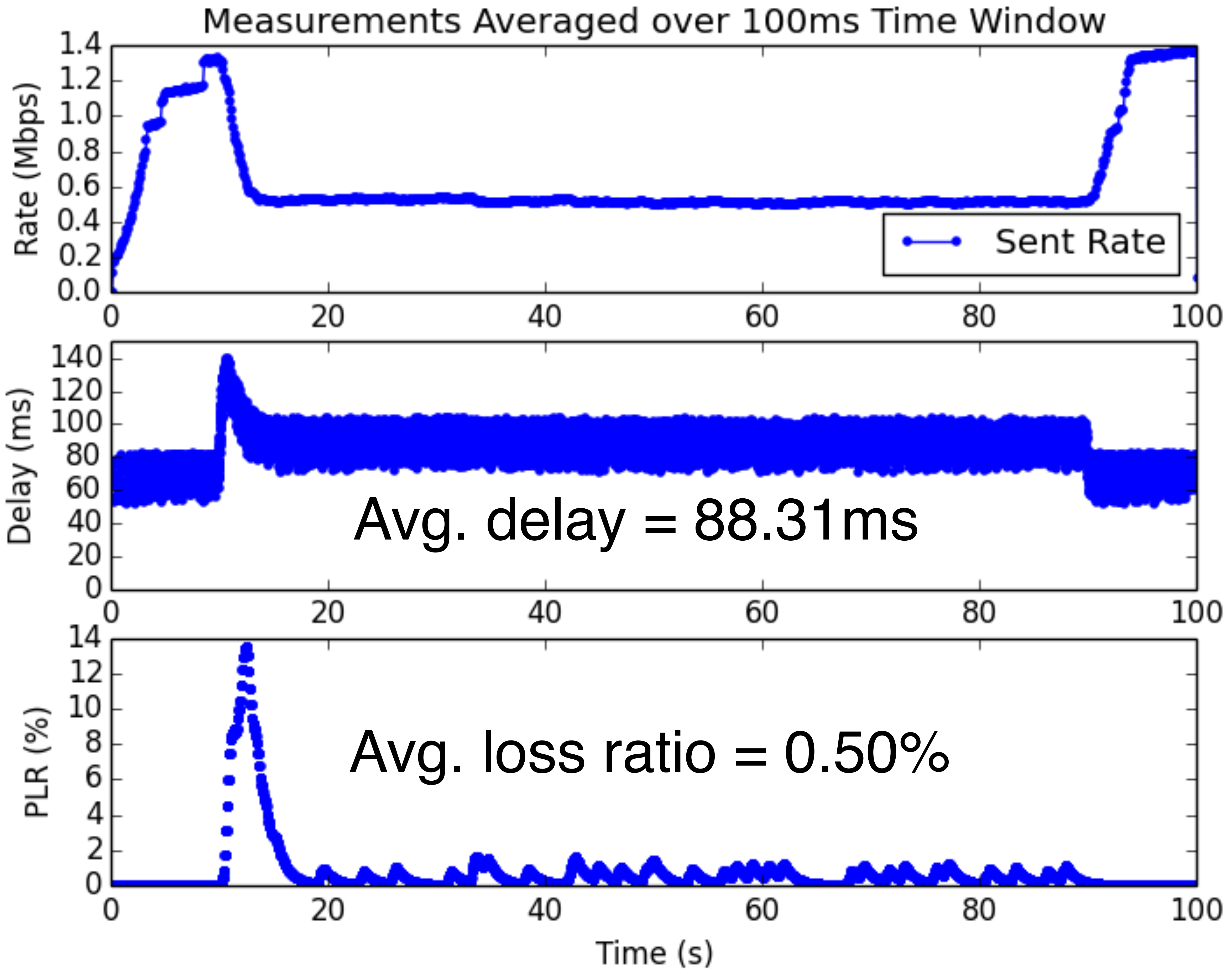

NADA Interaction with AQM: PIE

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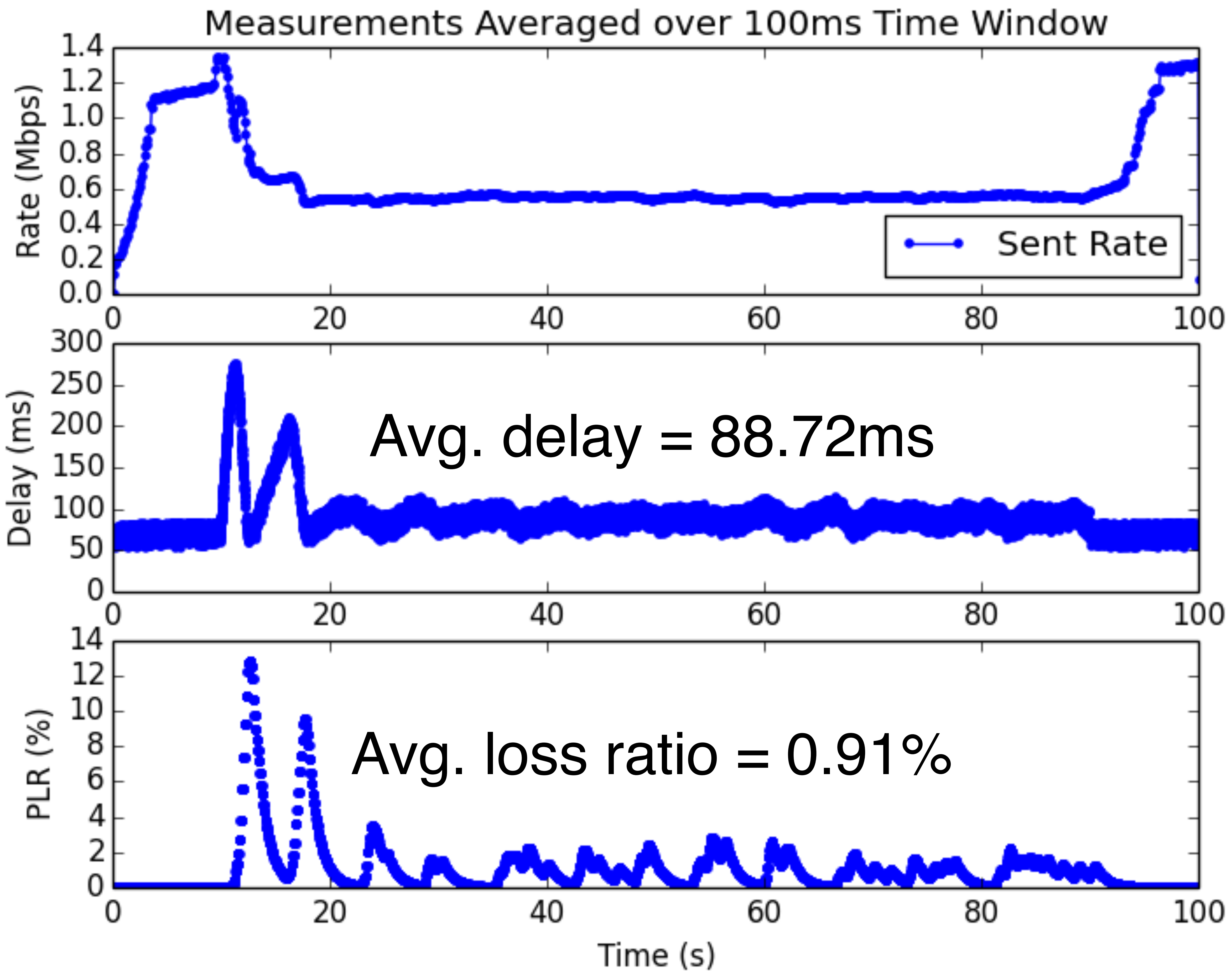

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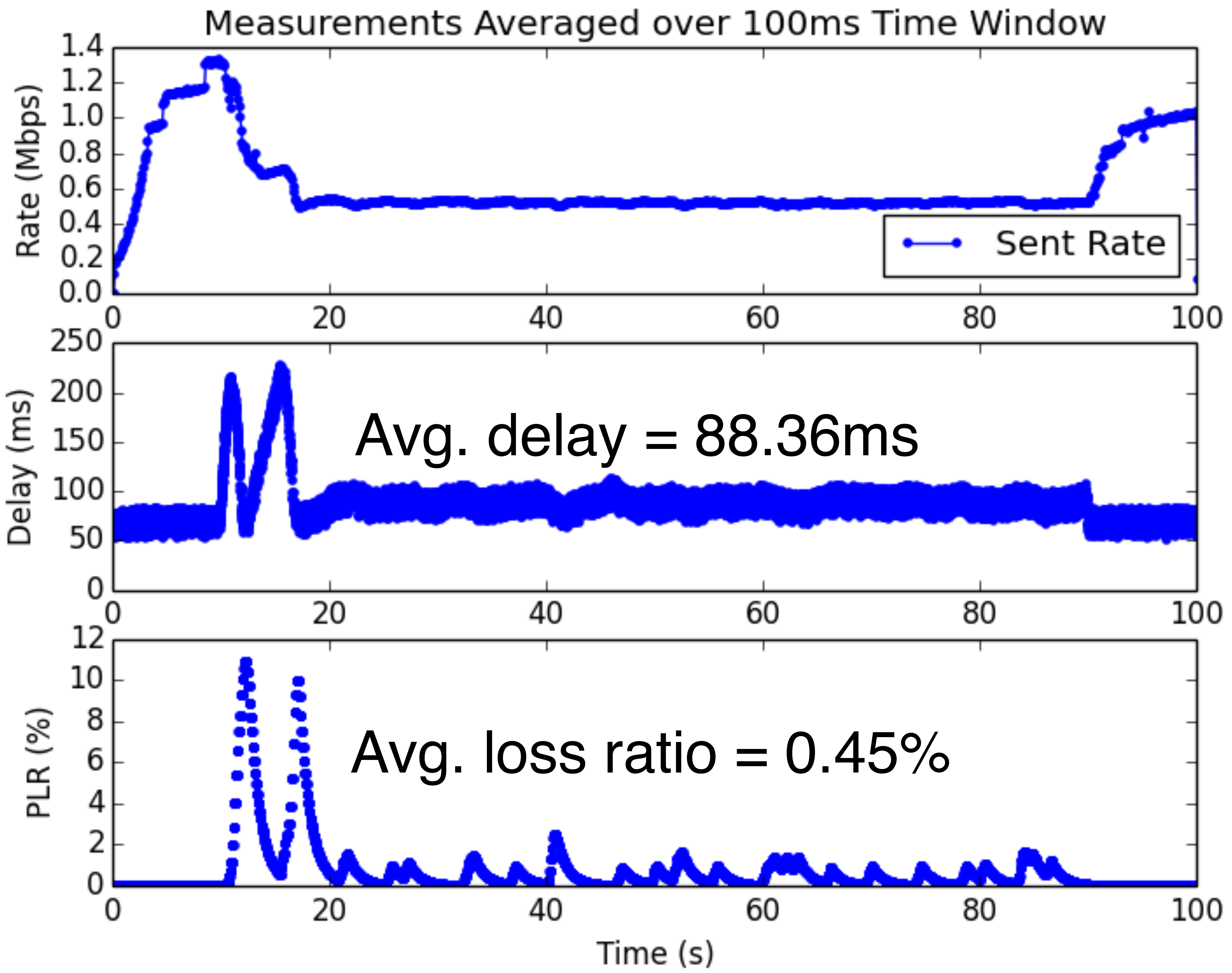

NADA Interaction with AQM: Summary

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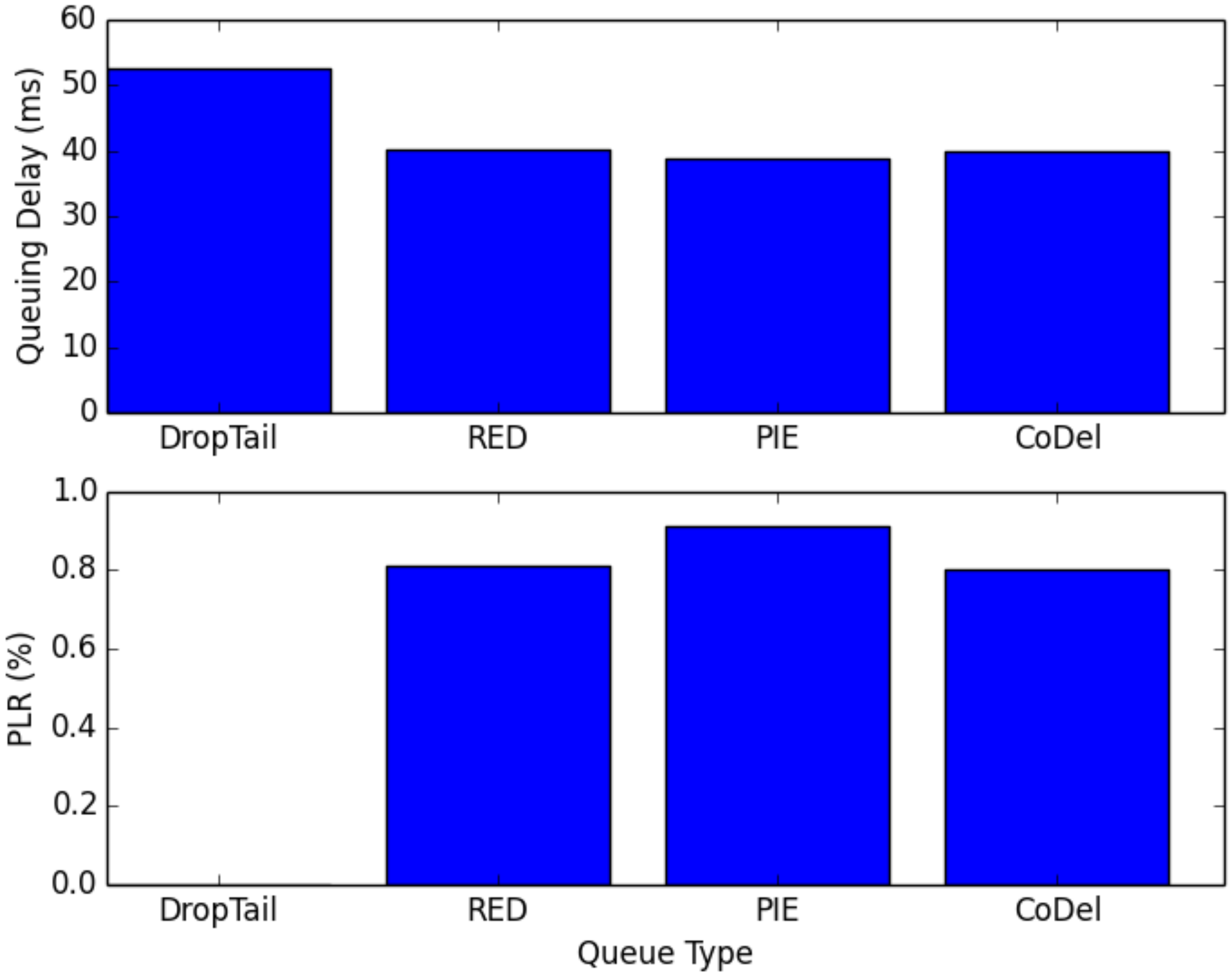

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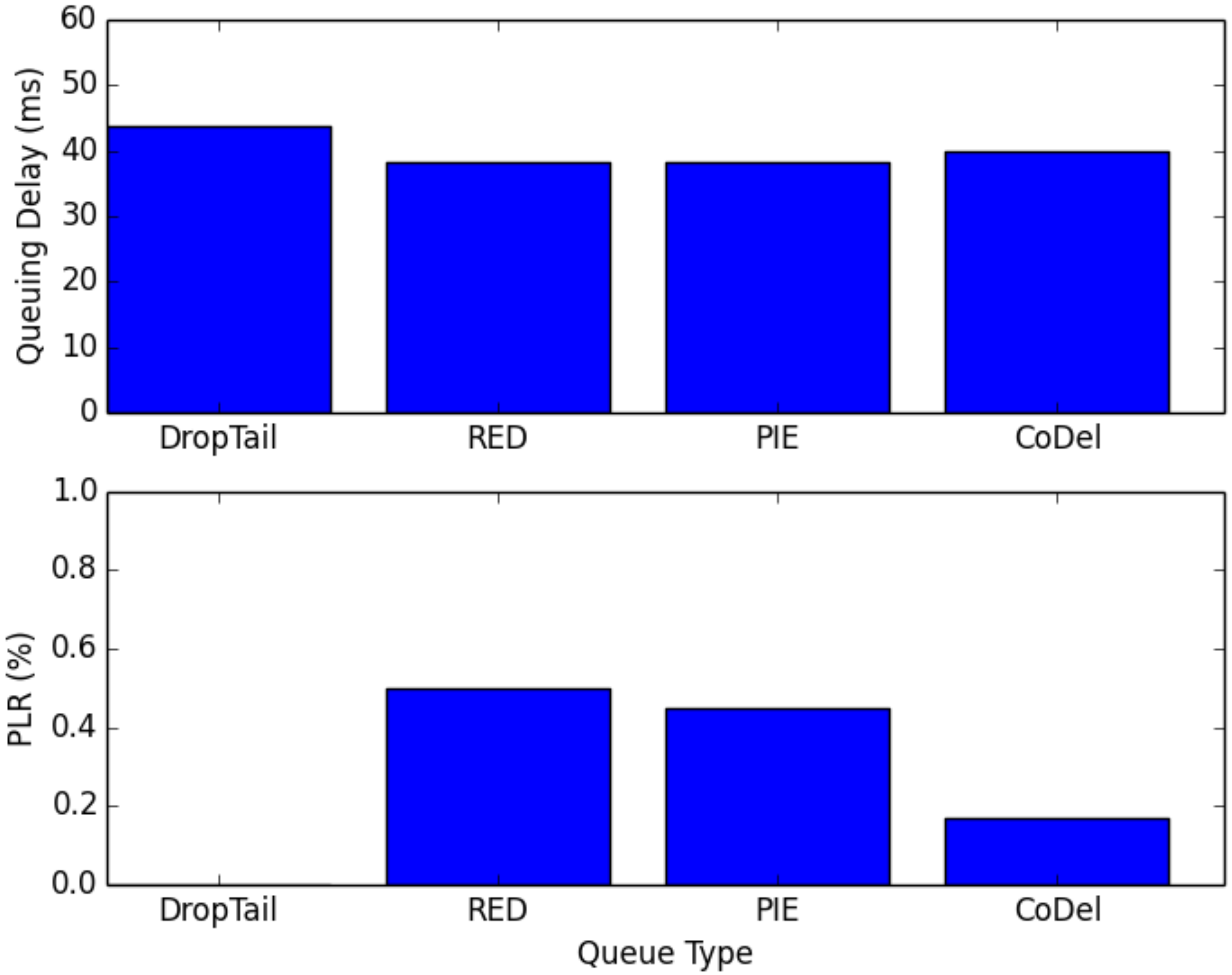

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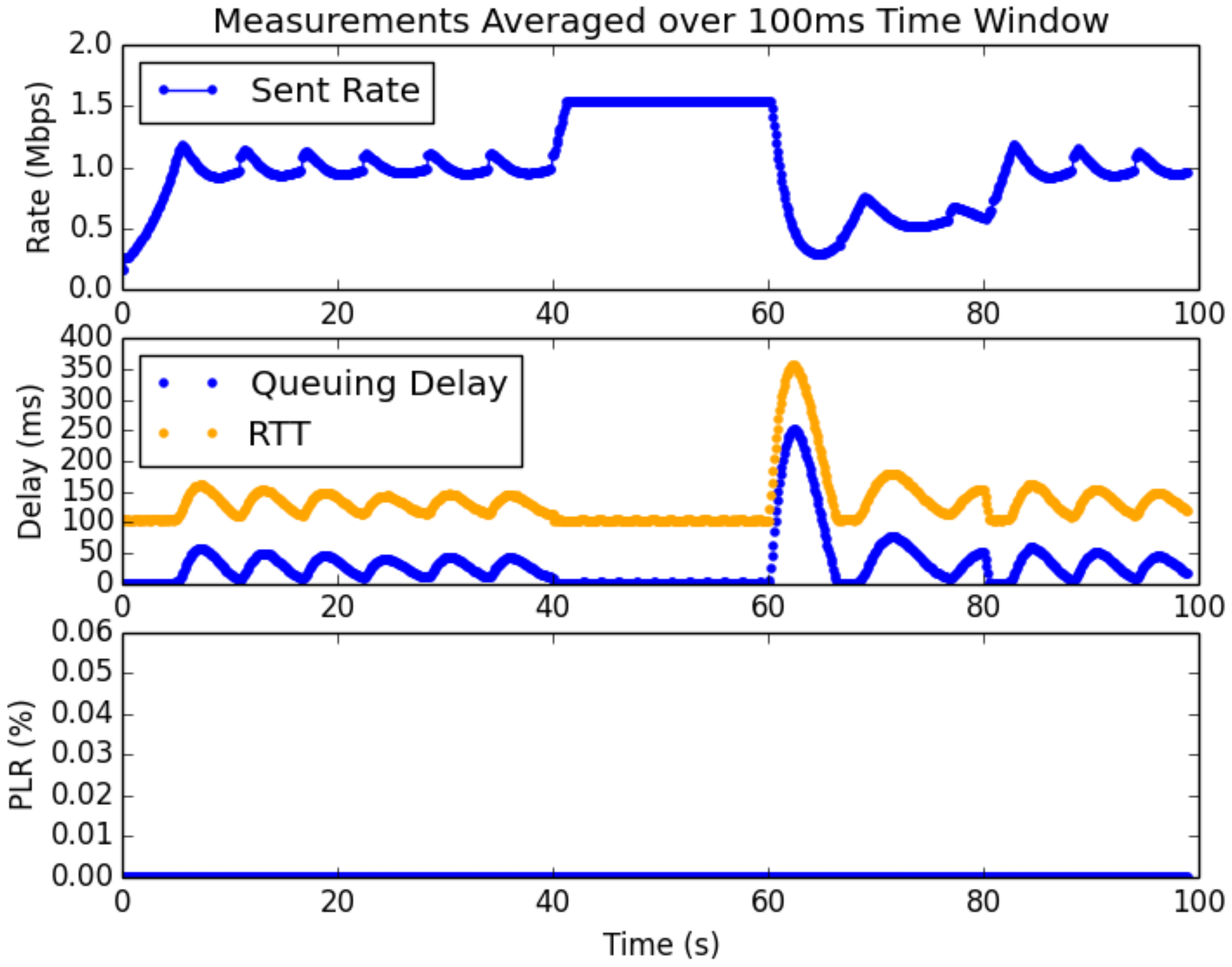
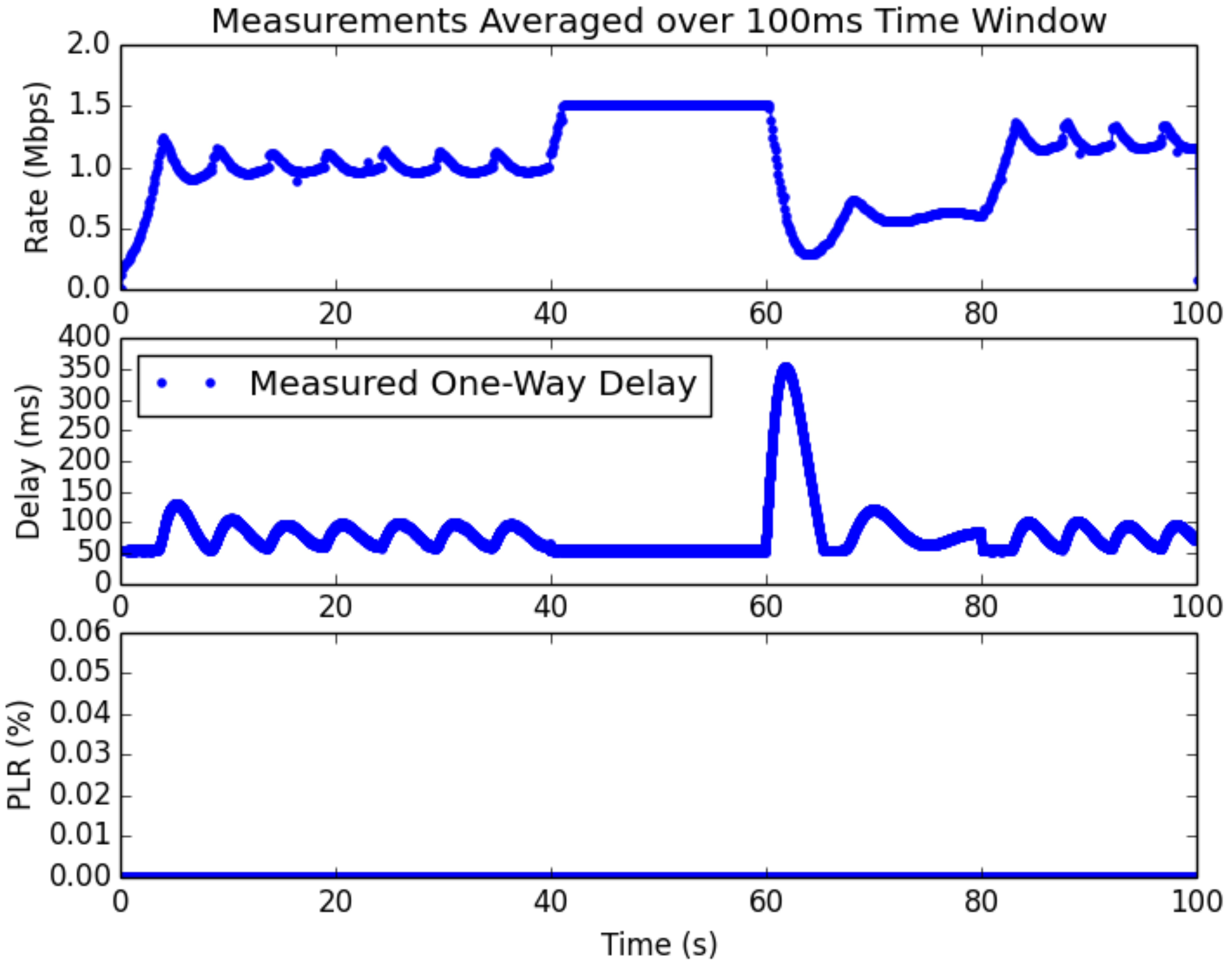
5.1 Variable Available Capacity with Single RMCAT flow (Using UDP as Background Traffic, No Additional Delay Jitter)

NS-2 result



NS-3 result



Impact of Parameter Values — Accelerated Ramp-Up

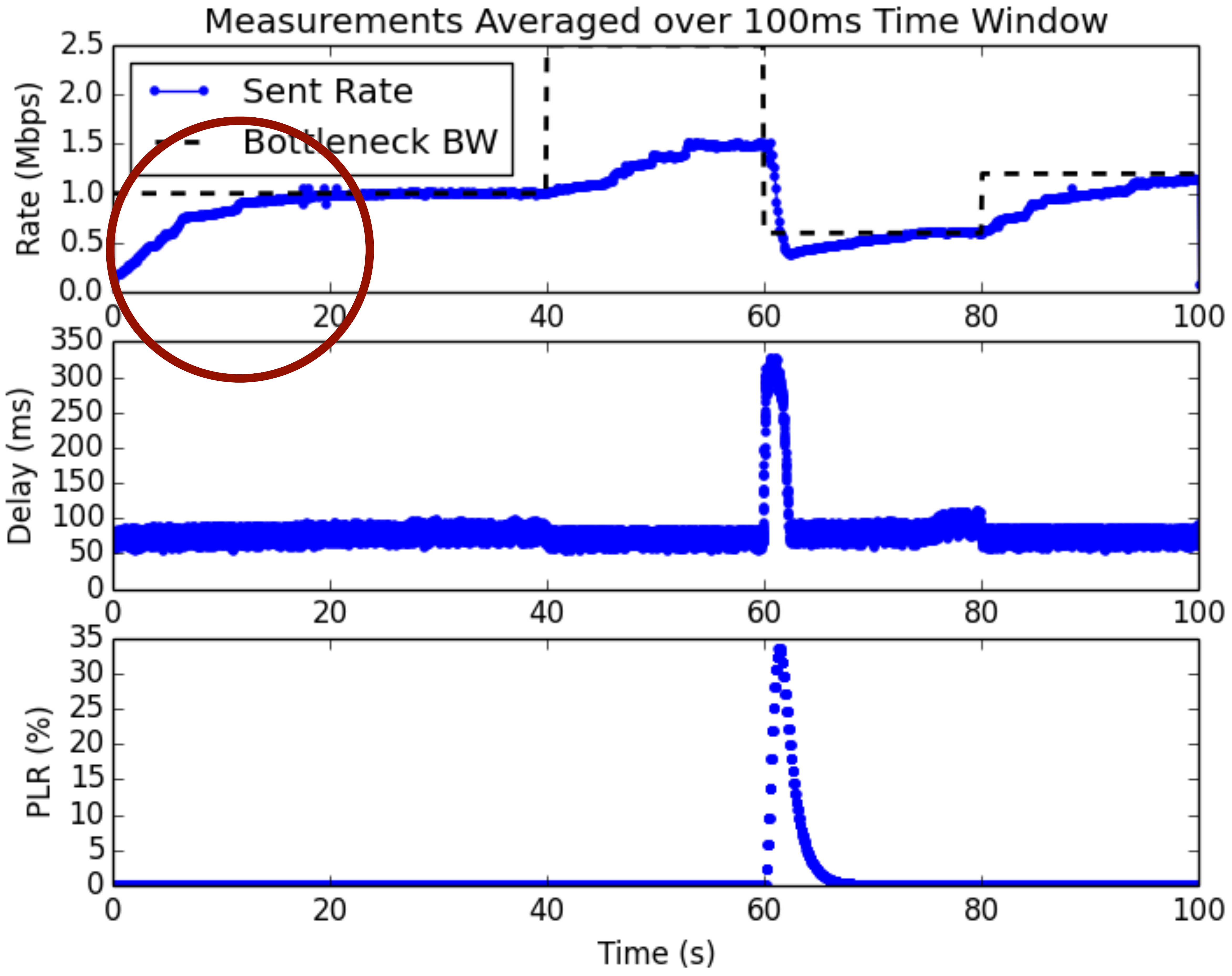
$$\text{gamma} = \min\left(\text{GAMMA\_MAX}, \frac{\text{QBOUND}}{\text{rtt+DELTA}}\right)$$

$$\text{r\_n} = \max(\text{r\_n}, (1+\text{gamma})\ \text{r\_recv})$$

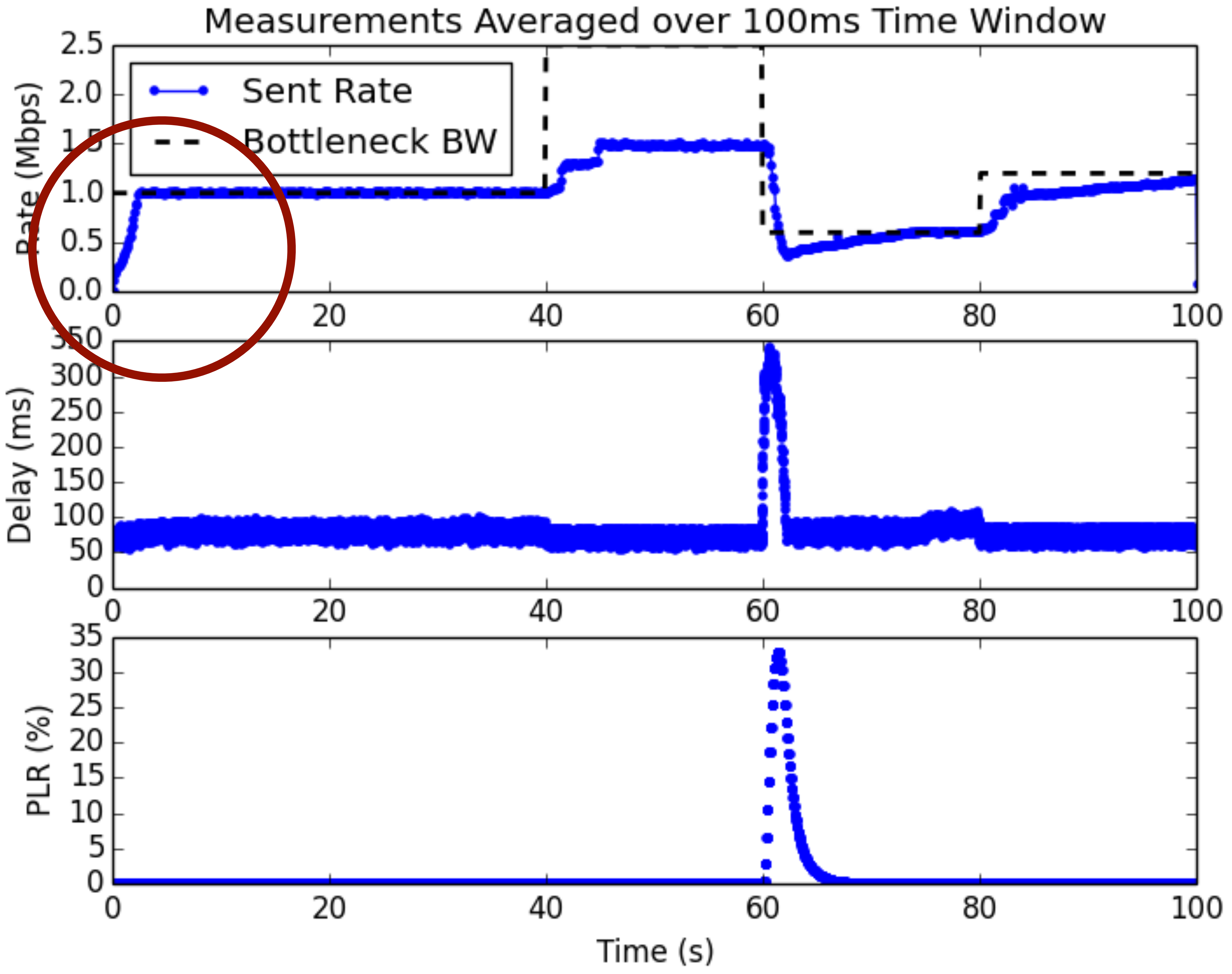
- GAMMA_MAX: Upper bound on multiplicative rate increase ratio
  - Determines aggressiveness of rate acceleration
  - Default value: 50%
- QBOUND: Upper bound on self-inflicted queuing delay;
  - Determines aggressiveness of rate acceleration
  - Default value: 50ms

5.1 Variable Available Capacity with Single RMCAT Flow

QBOUND=20ms



QBOUND=100ms



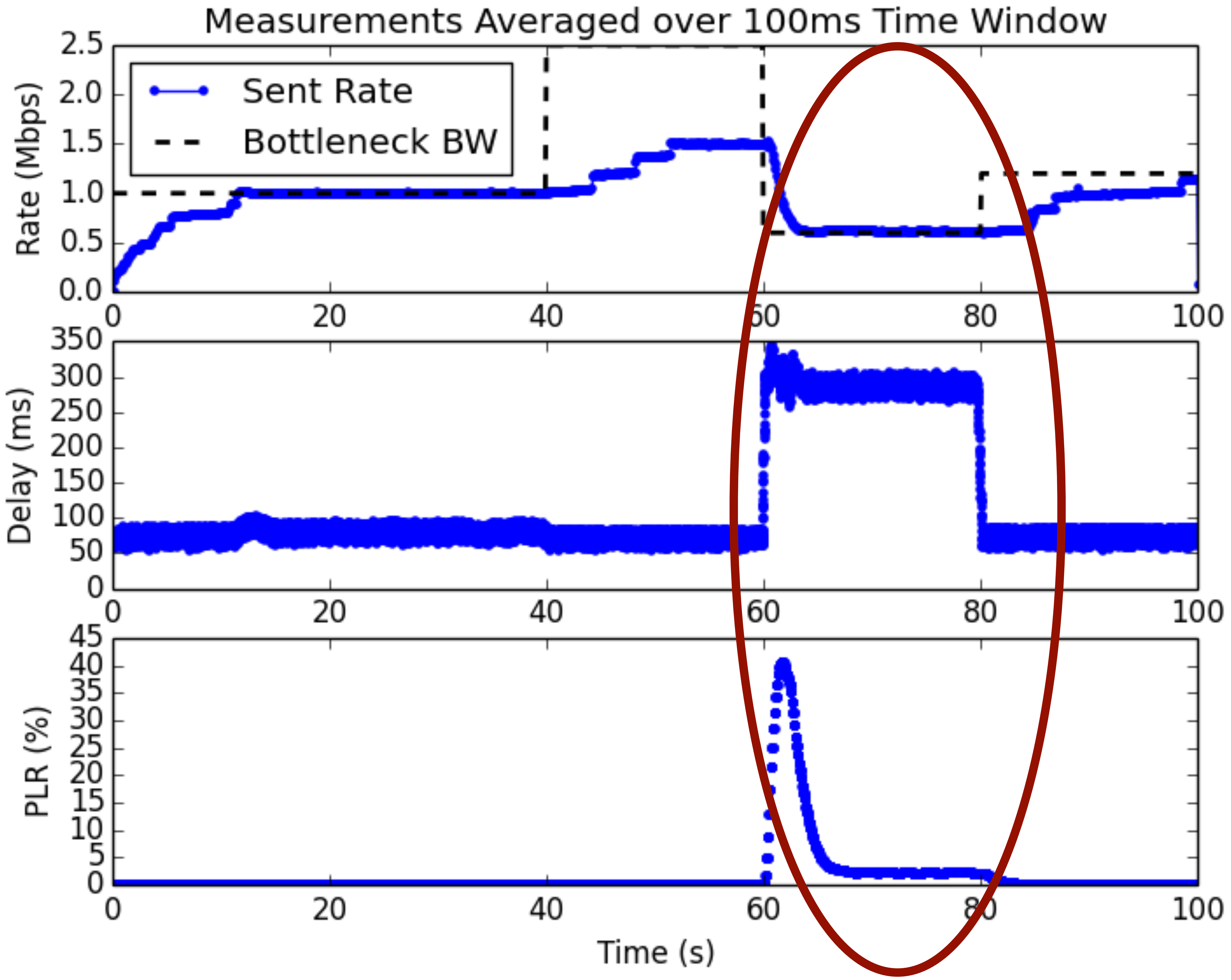
Impact of Parameter Values — Gradual Rate Update

$$r\_n = r\_n - KAPPA \cdot \frac{delta}{TAU} \cdot \frac{x\_offset}{TAU} \cdot r\_n - KAPPA \cdot ETA \cdot \frac{x\_diff}{TAU} \cdot r\_n$$

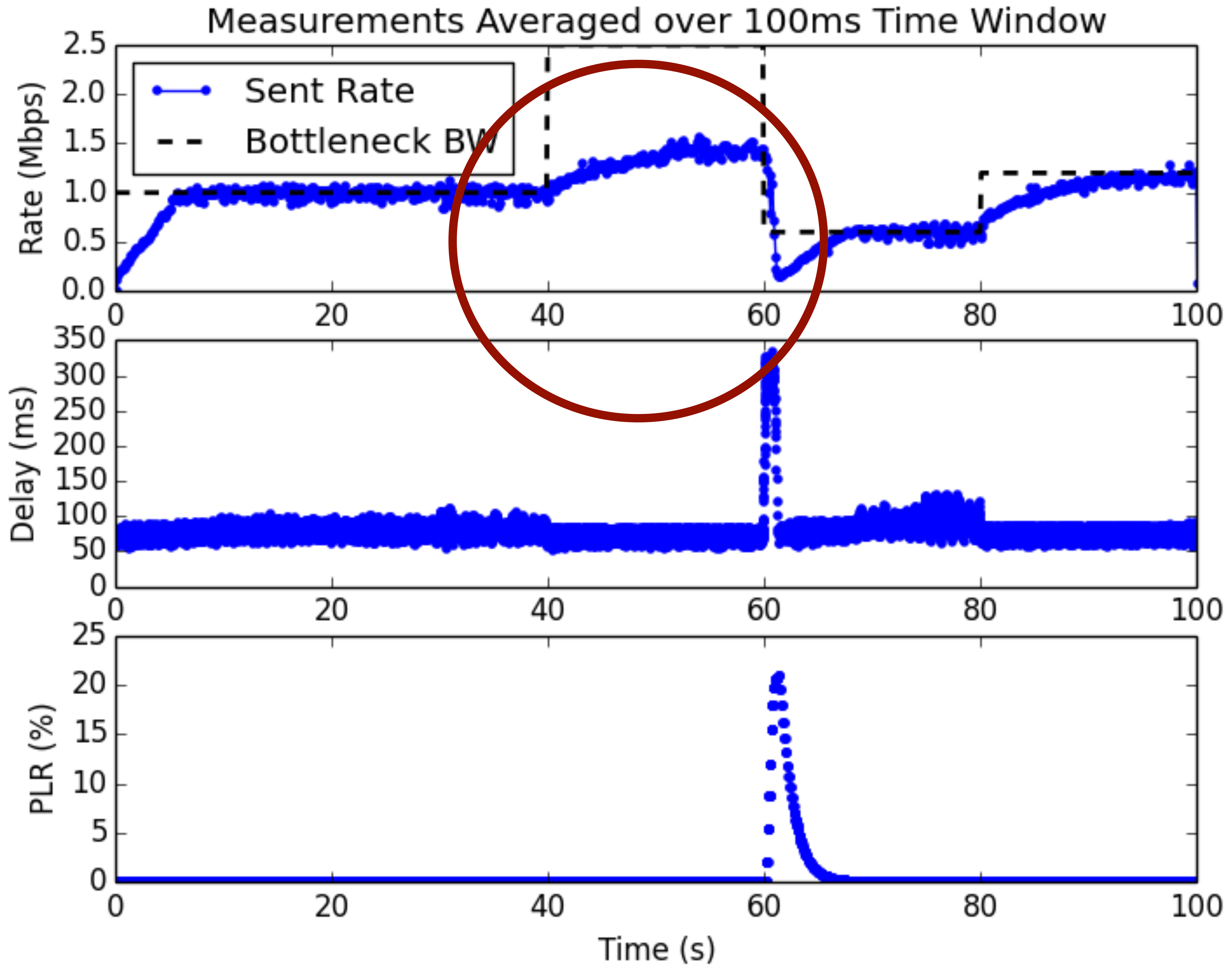
- TAU: Upper bound of RTT for guaranteed stability of congestion control feedback loop
  - Default value: 500ms
- ETA: Dictates relative influence between x_offset and x_diff to rate change
  - Default value: 2.0 (leading to a 10:1 influence between x_diff and x_offset when ACK interval delta = 100ms)
- KAPPA: Scaling factor for rate update
  - Determines overall aggressiveness of rate adaptation, trade-off between responsiveness and stability
  - Typical choices: 0.2 ~ 2.0; Default value: 0.2

5.1 Variable Available Capacity with Single RMCAT Flow

KAPPA=0.1: Slow recovery from loss



KAPPA=2.0: noisy rates at steady state



Summary of Open Issues

- Choice of delay metric: relative OWD vs. RTT
  - Drawback of using relative OWD (current scheme): later comer may confuse standing queue as part of path propagation delay
  - Drawback of using RTT: susceptible to noise along the feedback path
- Method for estimating delay, loss and marking ratio
- Impact of parameter values on algorithm performance
- Sender-based vs. receiver-based calculation of congestion signal and rate
  - Current scheme calculates x_n at receiver
  - Shifting the calculation to sender: simpler receiver yet slightly higher feedback overhead
- Incremental deployment: Droptail Queue -> ECN -> Advanced virtual queuing

Next Steps

- Algorithm analysis and improvement:
  - Impact of parameter choice in the presence of loss/marking
  - BW sharing between NADA and TCP flows
  - Fix issue with getting stuck in loss-based mode
- Evaluation efforts:
  - NS3-based evaluations for wired and wireless test cases
  - Evaluations driven by synthetic video traces and live video
  - Performance comparison against GCC and/or SCReAM

Backup Slides

Errata in Current Draft (-01)

- Section 4.1 Mathematical Notations:
  - In Figure 3: X_REF => XREF
  - In Figure 3: Default value of QTH: 100ms => 50ms
  - In Figure 3: Default value of GAMMA_MAX: 20% => 50%
- Section 4.3 Sender-Side Algorithm:
  - Change Eq. (4) to: r_n = max(r_n, (1+gamma)*r_recv)

See presentation in IETF-93:
http://www.ietf.org/proceedings/93/slides/slides-93-rmcat-0.pdf