A Delay Based Congestion Control Candidate

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Details in: draft-alvestrand-rtcweb-congestion

Problem

At what bitrate can a sender transmit data while still keeping the end-to-end delay low and avoiding packet loss?

What is RRTCC?

- Receive-side delay-based estimation of available bandwidth with the goal of minimizing contention.
- Based on filtered packet inter-arrival times.
- Inter-arrival time > 0, queues are building up.
  - Back off.
- Inter-arrival time < 0, queues are draining.
  - Hold.
- Otherwise, queues are stable.
  - Increase.

Modeling

Over-using:

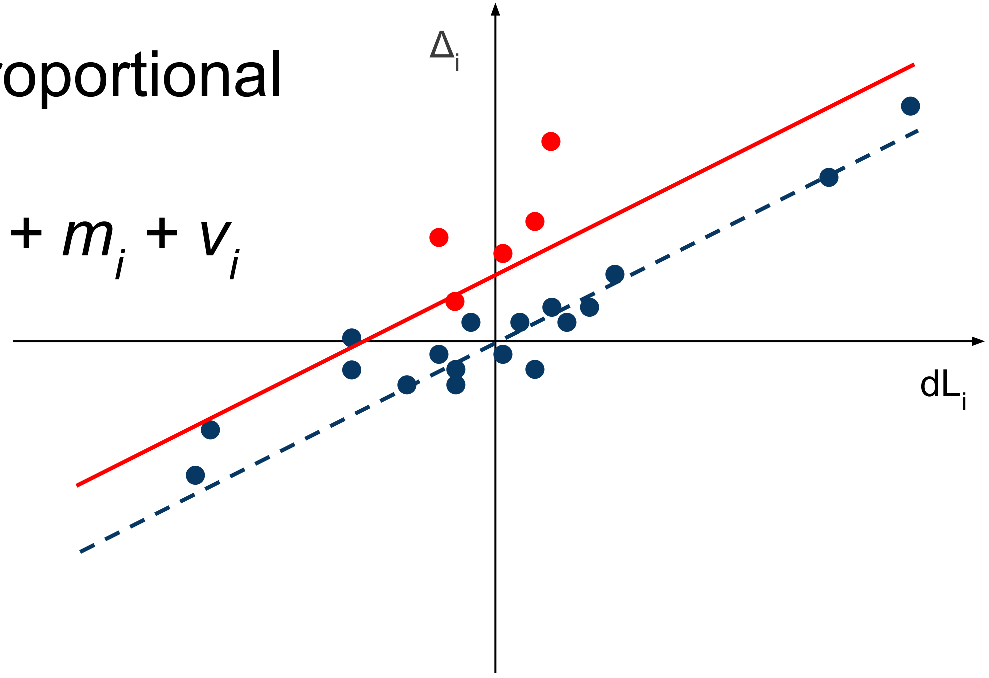
The one-way delay d_i increases as queues are being filled.

$\Delta_i = d_i - d_{i-1} > 0$

Approximately inversely proportional to the capacity:

$\Delta_i = dL_i/C_{min} + w_i = dL_i/C_{min} + m_i + v_i$

$E\{v\} = 0$



TODO

- Better self-fairness under different noise.
- Handle AQM/ECN/packet loss at receiver.
- Multiple RTP streams.
- Compete with TCP.

Backup Slides

Estimation/Detection

- Estimate the slope and offset.

- Most filters will do the job. We chose the Kalman filter.
  - Adaptive, handles random jitter as noise.

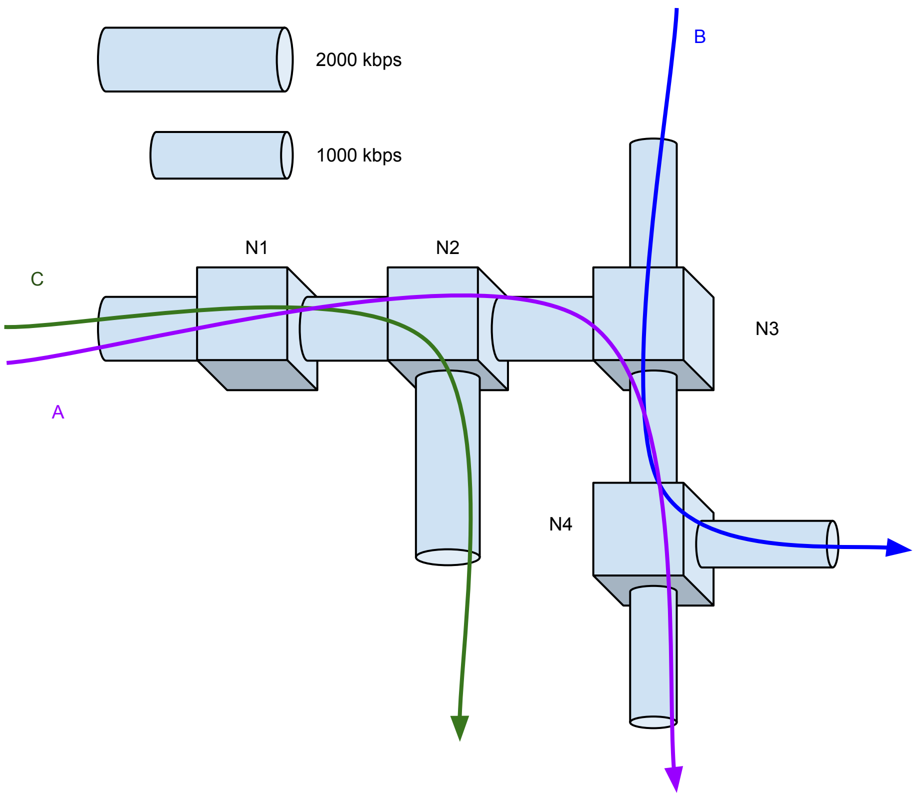
- Measure incoming rate when offset > threshold.

- Adjust target rate to some factor of the incoming rate.

Signaling

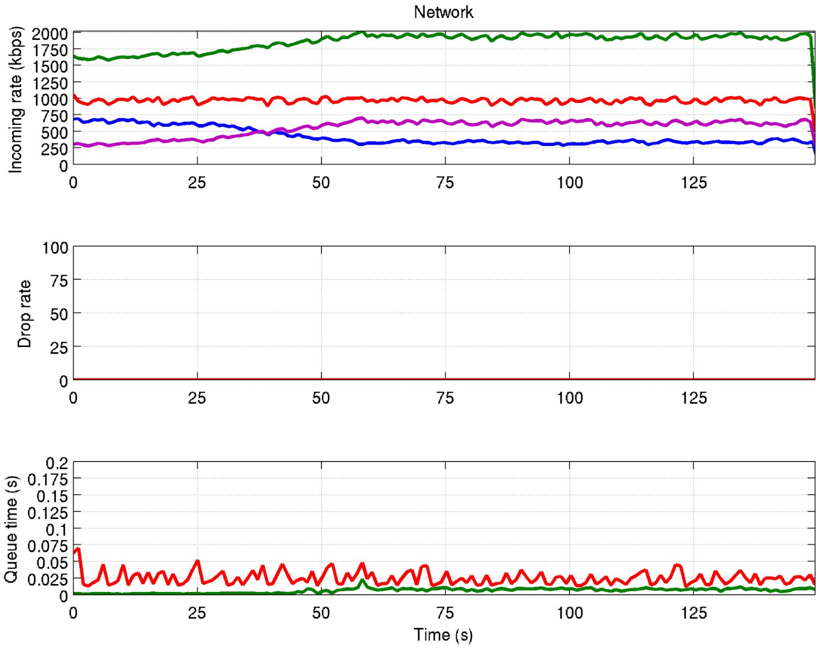
- Both estimation and control at the receiver.
- Transmit bandwidth estimates to the sender.
- The sender chooses to transmit at any rate < BW estimate. Employs own simpler algorithm to avoid problems of lost feedback messages.

Self-fairness - Problems



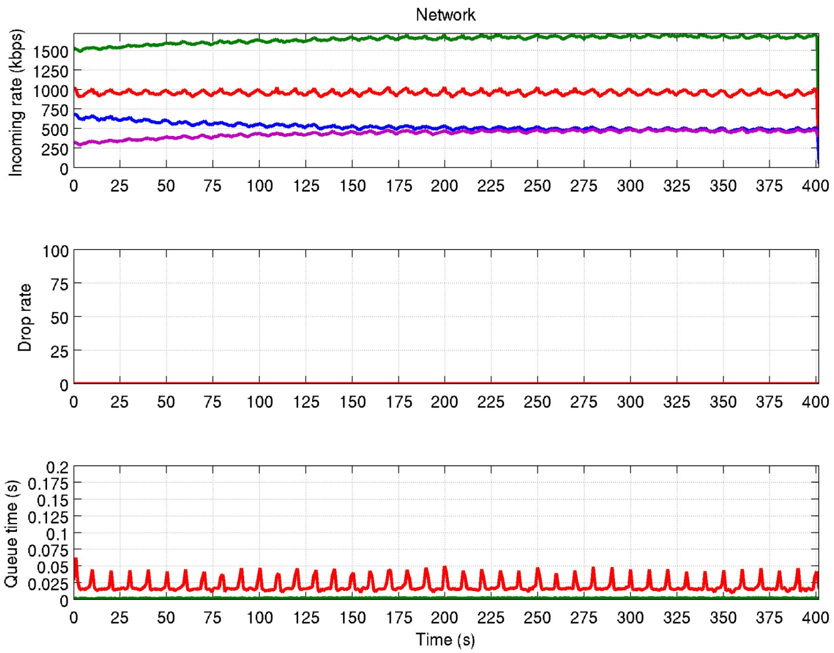
- Flow A and B are controlled by RRTCC.
- Flow C is constant at 1.3 Mbps.
- Flow A is "noisier" than B due to C.

Self-fairness - Problems



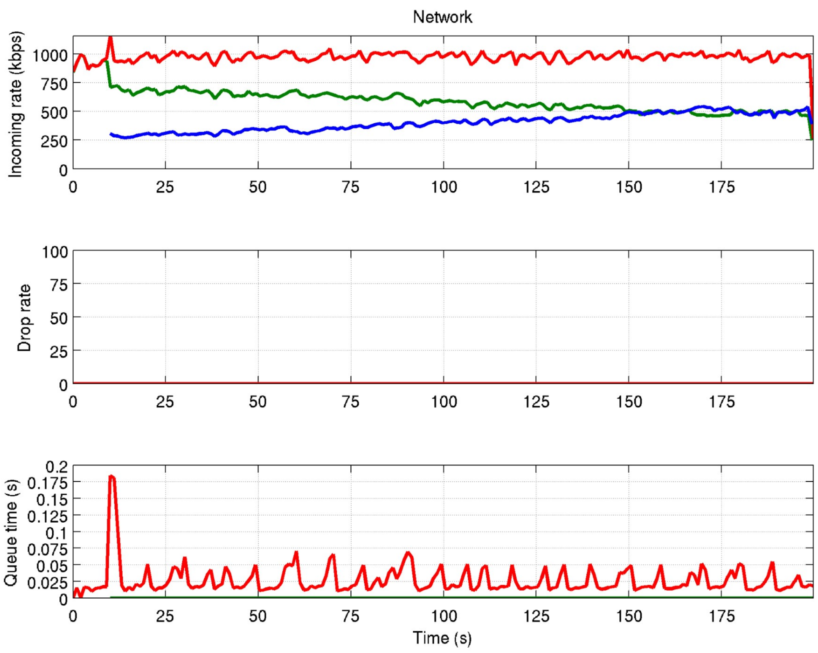
- Different amount of cross traffic.
  - Flow A is more noisy than B due to significant cross traffic at N1.
  - Noisier signal means more filtering and slower detection.
  - Flow B loses against flow A.

Self-fairness - Possible solution



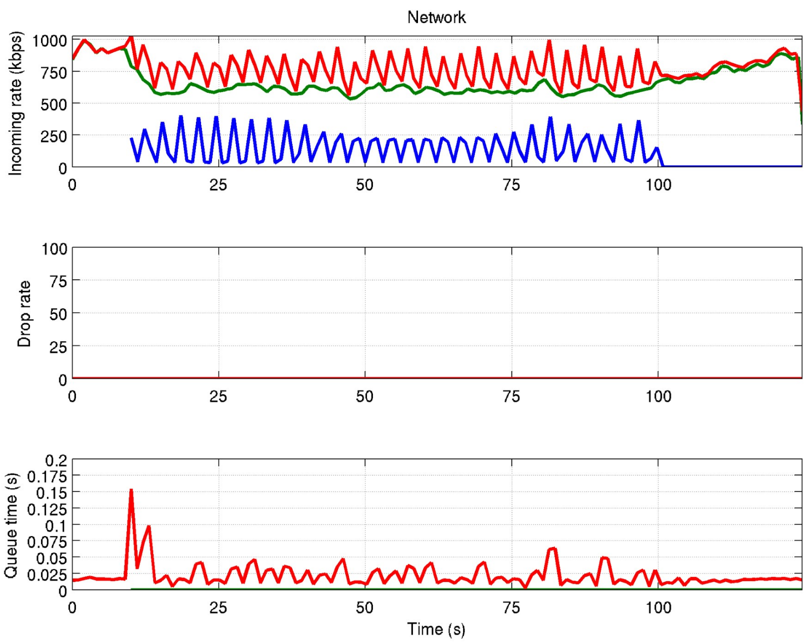
- Fixed noise variance.
- Additive Increase, Multiplicative Decrease.
- Send-side smoothing.

Late Newcomer



- Not an issue.
  - Monitoring delay changes.
  - No base-delay which can be biased.
  - Reduces to a self-fairness problem.

Bursty Cross-traffic



- Cross traffic toggles between 0 and 400 kbps every 0.2 s.
- AIMD and noise variance fixed at 50.
- Similar behavior with MIMD and adaptive noise variance.