UiO : University of Oslo

Shared Bottleneck Detection for Coupled Congestion Control for RTP Media Update (draft-hayes-rmcat-sbd-02)

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[simula . research laboratory]

R / T E
REDUCING INTERNET TRANSPORT LATENCY

SEVENTH FRAMEWORK PROGRAMME

Mechanism based on Summary Statistics

Why summary statistics?

- To limit feedback from receivers
- To deal with noise
- To deal with differing path lags

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Statistics Used

- a measure of delay variance (**var_est**)
- a measure of delay skewness (**skew_est**)
- a measure of delay oscillation (**freq_est**)
- a measure of packet loss (**pkt_loss**), a supplementary measure.
- *not a closed list*

Overview of work so far

The mechanism has been demonstrated using:

- Simulation experiments with multiple hops, changing bottlenecks, and realistic background traffic.
- Real network tests over the Internet and 3G mobile using NORNET(https://www.nntb.no/)

Publication

D. A. Hayes, S. Ferlin, and M. Welzl. Practical passive shared bottleneck detection using shape summary statistics.
In *Proc. of the IEEE Local Computer Networks (LCN)*, pages 150–158, Sept. 2014.
URL http://dx.doi.org/10.1109/LCN.2014.6925767

Key changes in -02

Some terminology improvements

Section on reducing noise in the statistical estimators

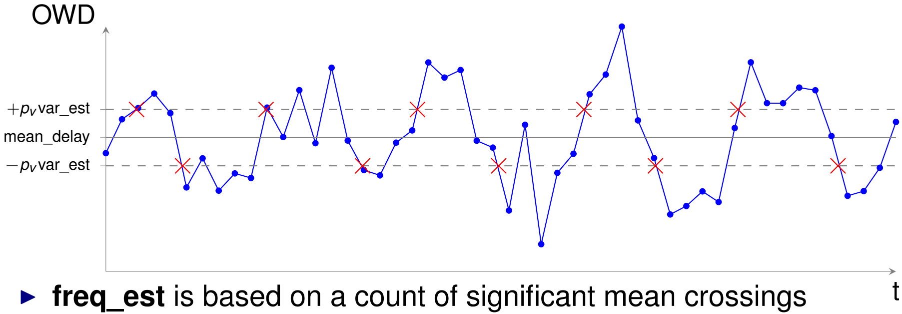
- removing noise from **freq_est** due to periods where there is no congestion
- removing bias in **skew_est**
- a simple adjustment for clock drift

Section on decreasing decision lag

- e.g. changes in networks and new signals

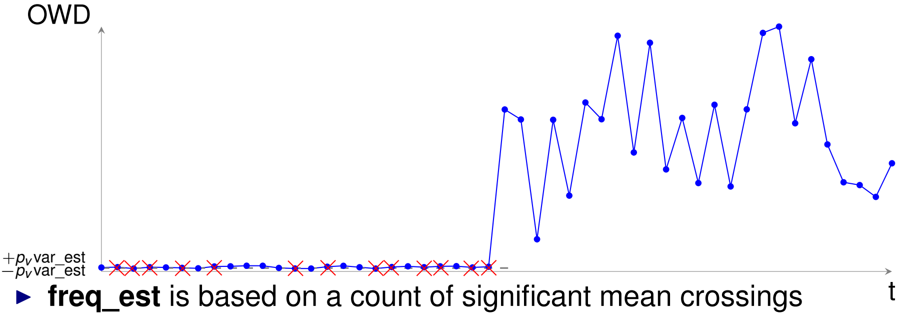
These are minor improvements that can improve the performance in certain circumstances.

Removing noise in freq_est



- **freq_est** is based on a count of significant mean crossings

Removing noise in freq_est



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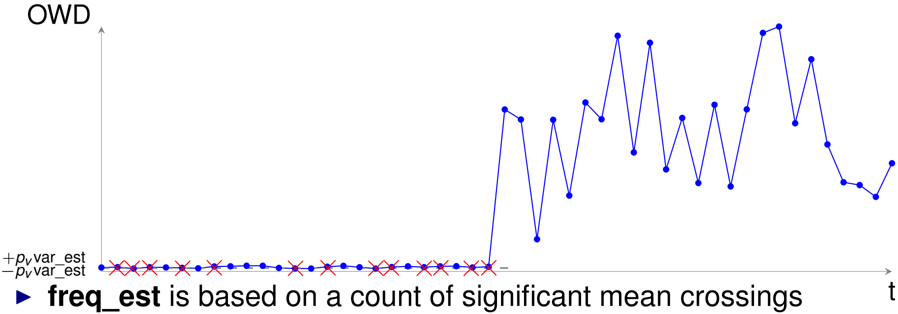

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Enhancement:

Only use PDV values obtained when path is congested (by **skew_est**)

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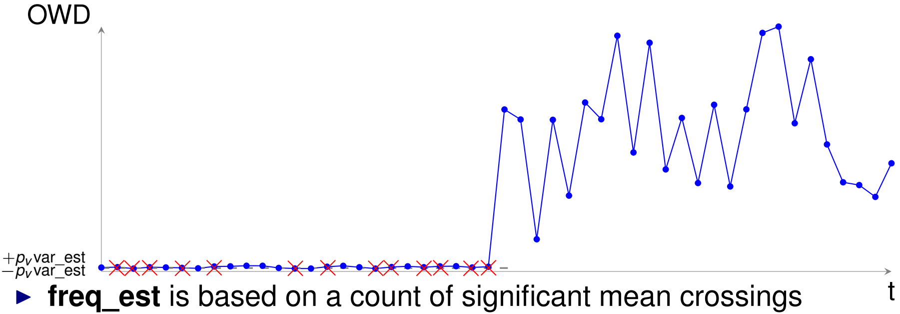

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Enhancement:

Only use PDV values obtained when path is congested (by **skew_est**)

- PDV $=$ NaN when no congestion
- var_est $= \dfrac{\text{sum\_M(PDV!} = \text{NaN)}}{\text{num\_VM(PDV)}}$

Removing small sample bias in skew_est

Bias

- a minority of small sample size **skew_est_T** can bias **skew_est**

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Avoiding bias

$$\text{skew\_base\_T} = \text{sum\_T}(\text{OWD} < \text{mean\_delay}) \\ -\text{sum\_T}(\text{OWD} > \text{mean\_delay})$$

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Avoiding bias

$$\text{skew\_base\_T} = \text{sum\_T}(\text{OWD} < \text{mean\_delay}) - \text{sum\_T}(\text{OWD} > \text{mean\_delay})$$

$$\text{skew\_est} = \frac{\text{sum\_MT}(\text{skew\_base\_T})}{\text{num\_MT}(\text{OWD})}$$

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Clock drift

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Possible approaches

- M<N helps, but at the expense of poorer estimates.
- Linear correction based on a history of selected min(OWD)
  - Uses state not currently kept, but being investigated.
- Proposed approach is based on already stored E_T(OWD) values
  - modifies **mean_delay** calculation
  - may not track drift as well as using selected min(OWD), but
    - helps congestion determination when OWDs slowly fall.

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4. Clock Drift per T: $$\text{CD\_T} = \frac{(\text{Newer\_mean} - \text{Older\_mean})}{\text{N/2}}$$
5. Adjusted mean: $$\text{mean\_delay} = \text{E\_M(E\_T(OWD))} + \text{CD\_T} * \text{M/2}$$

- Used as the basis for **skew_est** and **freq_est**.

Decreasing decision lag

Past and Present

- Measurement based mechanisms make decisions in the present based on what was measured in the past.
  - decision lag: can be several seconds

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Options

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- Reduce N and/or M — less accurate
- Exploit the fact that recent measurements are more important.

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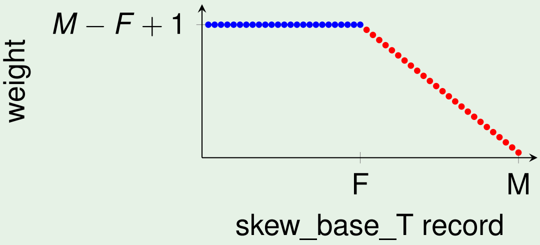
Weighting

- Old measurements are still important for stability
- EMA: infinite tail, not enough weight for recent values
- Linear decreasing weights: not enough weight for recent values
- Propose a piecewise linear approach

Piecewise linear weighted **skew_est** to reduce lag



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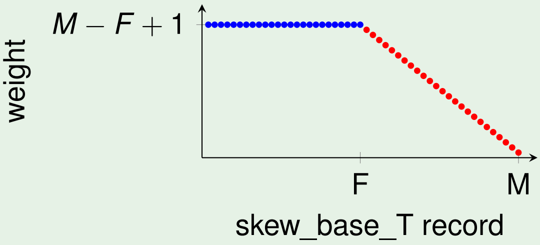

$$\text{skew\_est} = \frac{(M - F + 1) * \text{sum}(\text{skew\_base\_T}(1 : F)) + \text{sum}([(M - F) : 1] .* \text{skew\_base\_T}(F + 1 : M))}{(M - F + 1) * \text{sum}(\text{numsampT}(1 : F)) + \text{sum}([(M - F) : 1] .* \text{numsampT}(F + 1 : M))}$$

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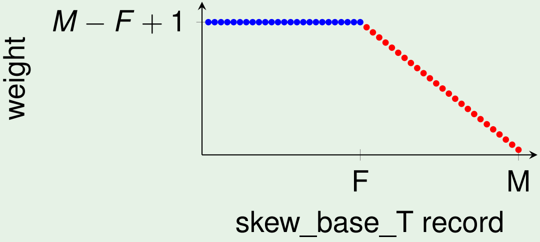

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- Simillarly for **var_est**

Conclusions and plans

- Outline the effect each threshold has on performance
- Define sender receiver interaction
- Evaluate the effect of time resolution
- Extend tests to wifi scenarios
- Journal
    - algorithm refinements
    - quantitative tests

Acknowledgements

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Extra slides