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# Delay-based Congestion Control for Low Latency

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## Why should we use delay-based congestion control?

The delay signal is:

- A measure of the quantity we are trying to reduce
- A fundamental characteristic of packet switched networks
  - requires no special signal
- May also aid in using available capacity more quickly

Ideally:

- A measurement based CC that tries to keep latency low

∴ congestion control for low latency,
**SHOULD** include delay as **A** congestion measure.





## Delay Measures

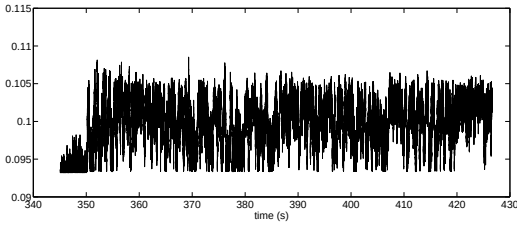
Measures:

- $T_{RTT}$
- $T_{OWD}$
- usually interested in $T_q$, but requires $T_{RTT\_min}$ or $T_{OWD\_min}$
- but with multi-path $T_{OWD}$ or $T_{RTT}$ maybe just as important as $T_q$
- gradient or change in delay
- ...





## Why is delay a difficult signal to use?




OWD signal

Dealing with Noise:

- Reverse path (RTT)
- Raw / probabilistic – collective behaviour matters
- Filtering: mean, median, exponential, kalman





## Coexistence?

Loss based (LB) congestion control and delay based (DB) congestion control do not coexist well

- LB tries to fill the queues
- DB tries to keeps them small

Hybrid two-state methods

- only reduces delay in the long term
  - (as loss based flows disappear)
  - long term is still important!





## A way forward

Delay based CC for:

- homogeneous systems (e.g. data centres)
- Scavenger class traffic
- small buffers
- incentives for deploying DBCC
  - perhaps policing
  - isolation of delay-based flows
- in combination with other signals (such as ECN)

DBCC is not ***THE*** solution, but should be ***PART*** of the solution