DCTCP & CoDel

the Best is the Friend of the Good

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IETF-84 TSVAREA Jul 2012

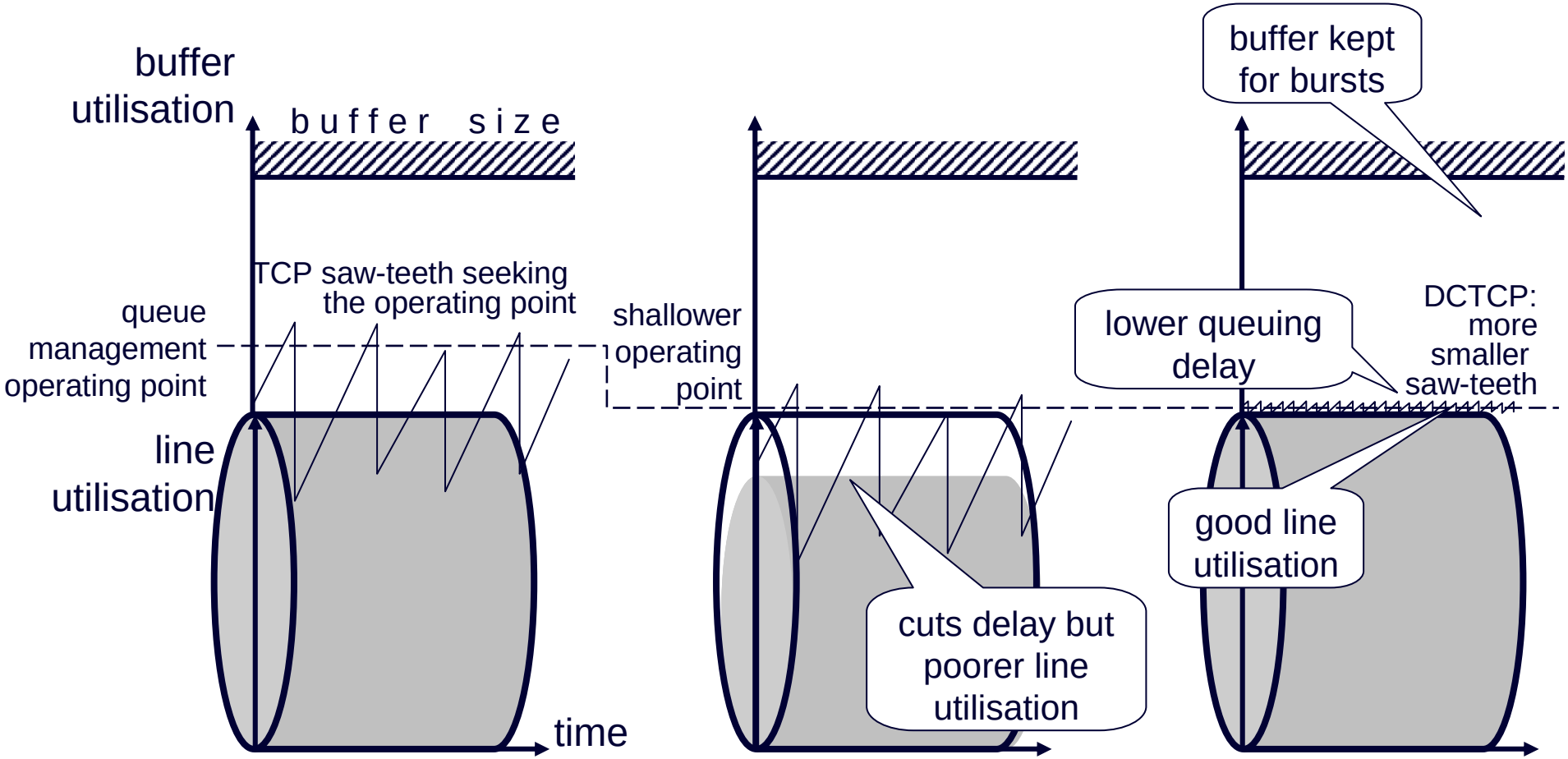
Voltaire

menu

1. why DCTCP is important
2. an (untested) roadmap
   how might DCTCP be deployed and co-exist with current Internet traffic & AQMs

Data Centre TCP (DCTCP)

high utilisation in steady state still leaves room for bursts



Today
TCP on end-systems
RED in queues

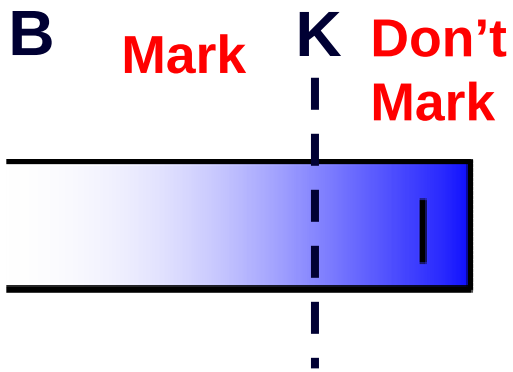
if solely change queues

change queues
and end-systems

Data Center TCP Algorithm

Switch side:

- Mark packets when **Queue Length > K**



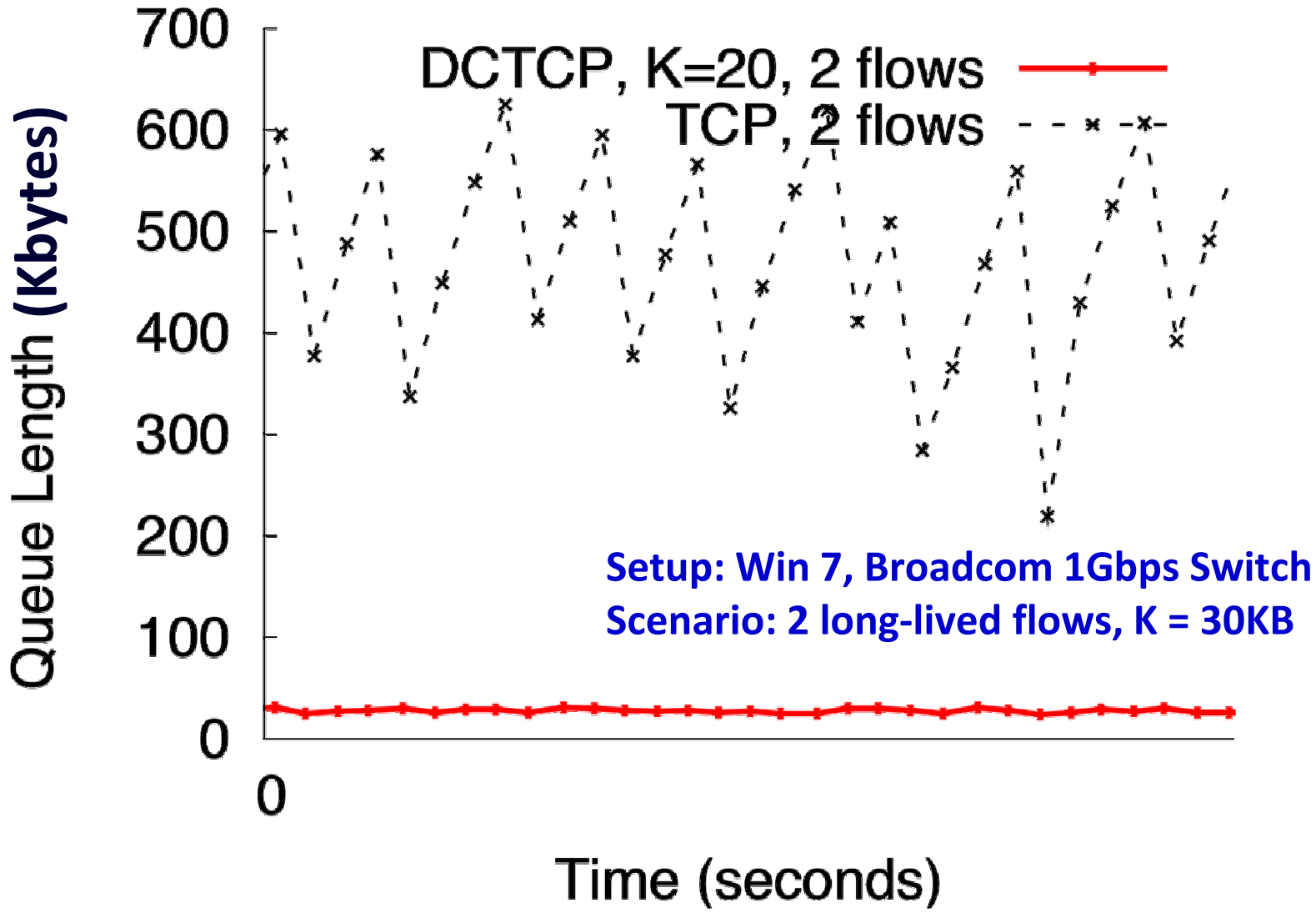
Sender side (differences from TCP New Reno):

- Maintain ***moving average*** of ***fraction*** of marked packets (α)

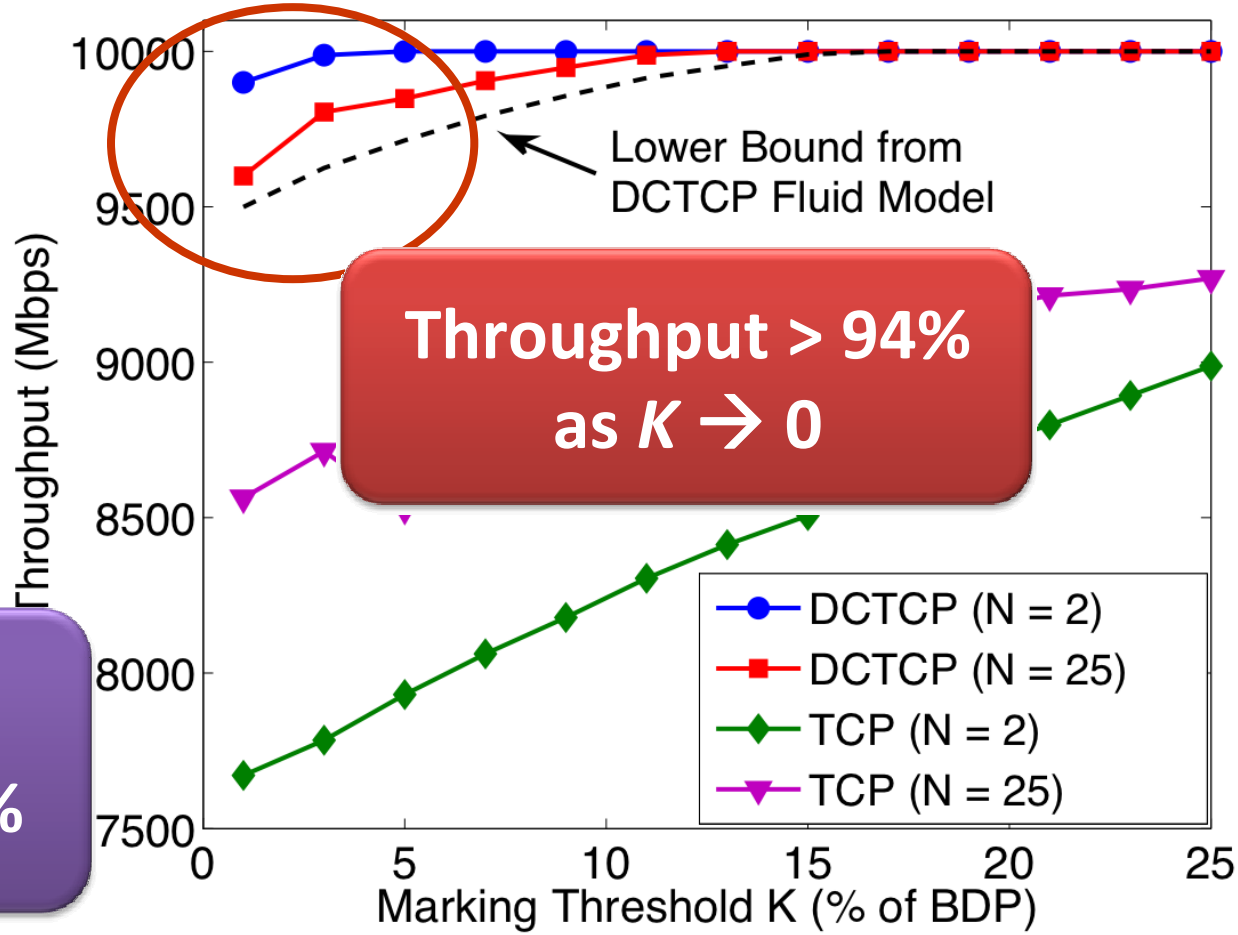
$$\text{each RTT}: \; F = \frac{\#\ \text{of marked ACKs}}{\text{Total}\ \#\ \text{of ACKs}} \quad \Rightarrow \quad \alpha \leftarrow (1-g)\alpha + gF$$

- Adaptive congestion window decrease: $W \leftarrow (1-\frac{\alpha}{2})W$

DCTCP in Action



Throughput-Latency Tradeoff



Throughput > 94% as $K \rightarrow 0$

For TCP: Throughput $\longrightarrow$ 75%

Parameters:

link capacity = 10Gbps

RTT = 480μs

smoothing constant (at source), g = 0.05.

DCTCP only for data centres?

- named for a feasible deployment scenario
  - a change to all senders, receivers and switches*
- not intended to be its sole applicability
  - addresses high bandwidth-delay product
  - should be applicable to slow links & long RTTs
  - only tested down to 100Mb/s so far†

100Mb/s x 500 µs
=
250kb/s x 200ms

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* Switches/routers only require reconfig if they support ECN
senders (and receivers) require implementation change

† An issue with a wide range of RTTs has been addressed

DCTCP activity

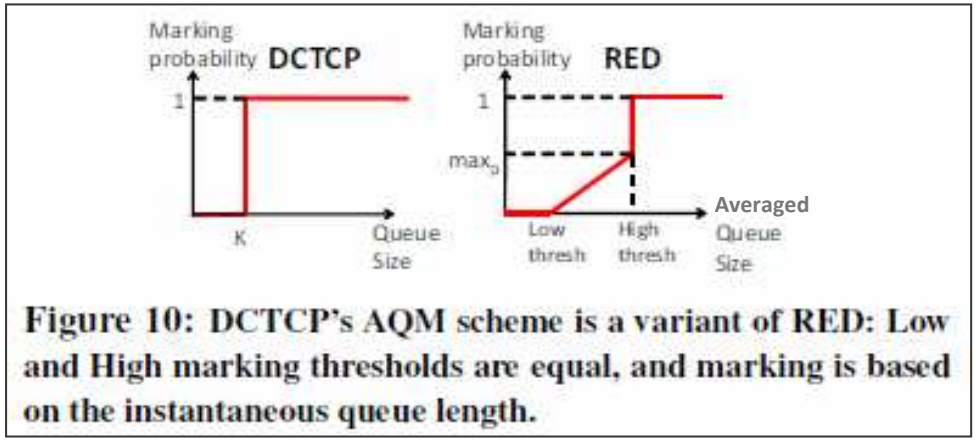


Figure 10: DCTCP's AQM scheme is a variant of RED: Low and High marking thresholds are equal, and marking is based on the instantaneous queue length.

Figures courtesy of Alizadeh et al

- E2e Transport
  - In Windows 8 Server data center template
  - I-D for DCTCP feedback (intended EXP) [draft-kuehlewind-tcpm-accurate-ecn-01]
- AQM
  - Existing kit: Just a degenerate config of RED
  - Can be implemented as just a step at K packets (single 'if' command)
  - For zero-delay can use a virtual queue [RC5670]
    - hardware implementations ["How to Build a Virtual Queue from Two Leaky Buckets"]
    - see HULL for specifics with DCTCP
- Analysis, papers, Linux & ns2 implementation, etc
  - <http://www.stanford.edu/~alizade/Site/DCTCP.html>
  - SIGCOMM paper gives entry point

DCTCP: differences from traditional AQMs
e.g. CoDel

- source smooths signals
  - not the queue
- source responds to extent of signals
  - not just their existence
- designed for ECN only

which node owns the RTT?

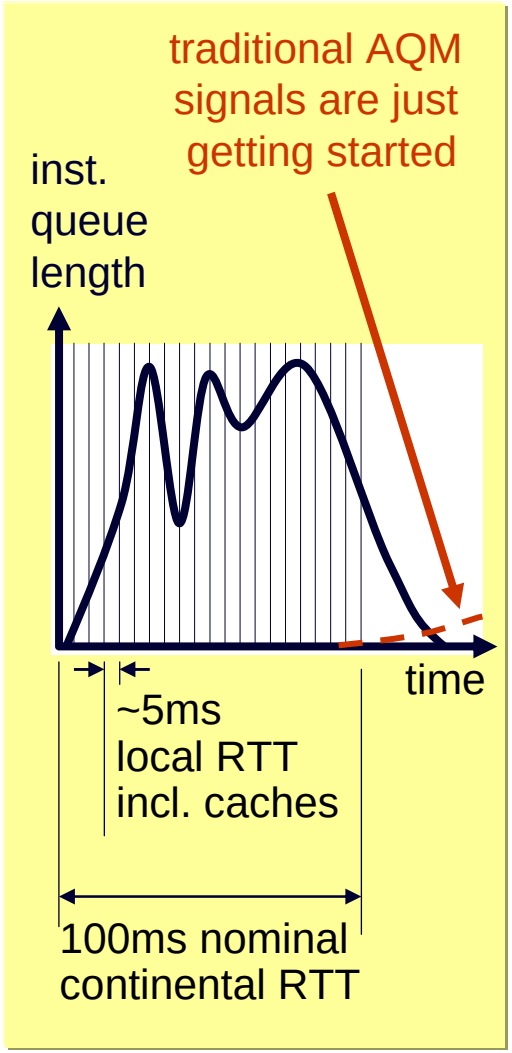
- we want to smooth away queues that disappear within ~1 RTT
  - but which RTT?

the network?

- traditional AQMs hold back signals for the ‘nominal’ worst-case (long RTT)
- DCTCP signals immediately
  - no ‘nominal’ RTT to configure / hard-code / adapt

the host?

- each DCTCP flow smooths over its own RTT
- short RTT flows can fill troughs & avoid peaks on behalf of longer ones (and themselves)



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But DCTCP’s approach only makes sense with ECN…

ECN and drop are not equivalent

- ECN is solely a signal
  - no problem sending out a burst of ECN and later smoothing it away at the source
- drop is both an impairment and a signal
  - simultaneously want to avoid it and hear it
  - a burst of loss can’t just be smoothed away
    - collateral damage from timeouts etc.

Can smoothing on the host interoperate with smoothing in the network?

current rule (paraphrased from RFC 3168)

- Signal ECN when queue would otherwise drop
- Respond to ECN exactly as a drop
- intended to prevent starvation of one by the other

proposal: overload the meaning of an ECN-capable pkt

- for queue, ECN also means SHOULD NOT smooth
- for transport, ECN also means SHOULD smooth
- under persistent congestion
  - need to ensure shares stabilise and no-one starves
  - despite different dynamics

interoperability

between old & overloaded meanings of ECN

queue \ host	one big instant response to ECN per RTT	small smoothed responses to each ECN
smoothed ECN	✓	✓[2]
instant ECN	✓[1]	✓

ticks are based on conjecture, not experimental evidence

[1] don't get full gain in latency until host upgrades as well
[2] doubly delayed response to congestion

message

- zero-config AQMs are good
  - CoDel for drop
  - simple step for ECN
    - far greater potential gains
- in parallel to CoDel field testing
  - work on interop with unsmoothed AQM for ECN
  - otherwise the lazy option (ECN = drop) prevails
  - would be a wasted opportunity

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Q&A

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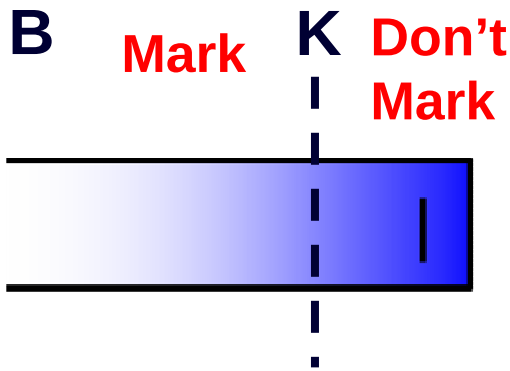

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