

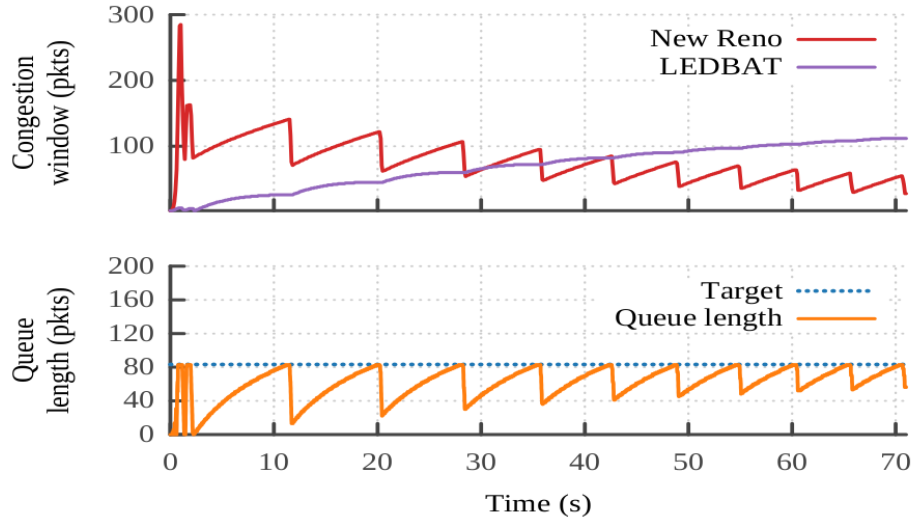
FLOWER, a *F*uzzy *L*OWER than Best-*E*ffo*R*t Protocol

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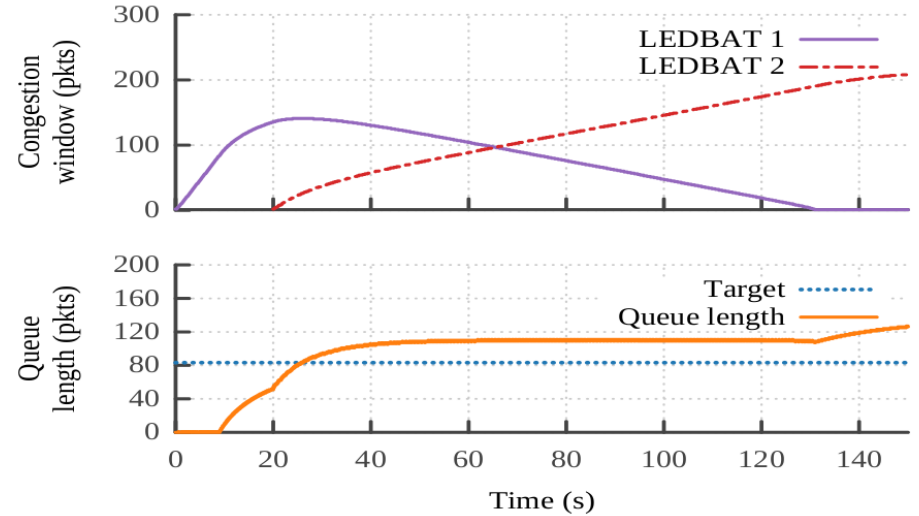


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Main LEDBAT Problems



Aggressiveness



Latecomer unfairness

Towards an Adaptive LBE Protocol

- LEDBAT does not have an optimal configuration and needs to be tuned as a function of the network state
- LEDBAT is not adaptive and only implements a P-type controller to control the sending rate as a function of the delay. Both parameters (target and gain) are fixed
- One possible solution would be to implement an adaptive functionality inside this P-type controller but such adaptation would require a fine grained analytical model

Towards an Adaptive LBE Protocol

- Our goal is to overtake this difficulty by using a fuzzy algorithm to perform such task
- Our proposal, named FLOWER :
 - Aims at proposing a novel LBE transport protocol based on a fuzzy logic algorithm
 - Aims at reacting better than LEDBAT front to congestion event

Why Fuzzy Logic?

- No computational complexity
- No supplementary parameters
- Allows to incorporate our heuristic knowledge about how to control the system.
- FLOWER can be seen as a replacement of the P-type controller of LEDBAT

How to Control the Queuing Delay?

- Inputs:
 - Error (offset):
$$e(k) = \tau - qd(k)$$
 - Change of error (gradient of error):
$$\Delta e(k) = e(k) - e(k - 1)$$
- Output: change of cwnd ($\Delta cwnd(k)$)
- The inputs and the output are related by fuzzy rules
 - S. Q. V. Trang et al., “FLOWER – Fuzzy Lower-than-Best-Effort Transport Protocol”, IEEE LCN 2015

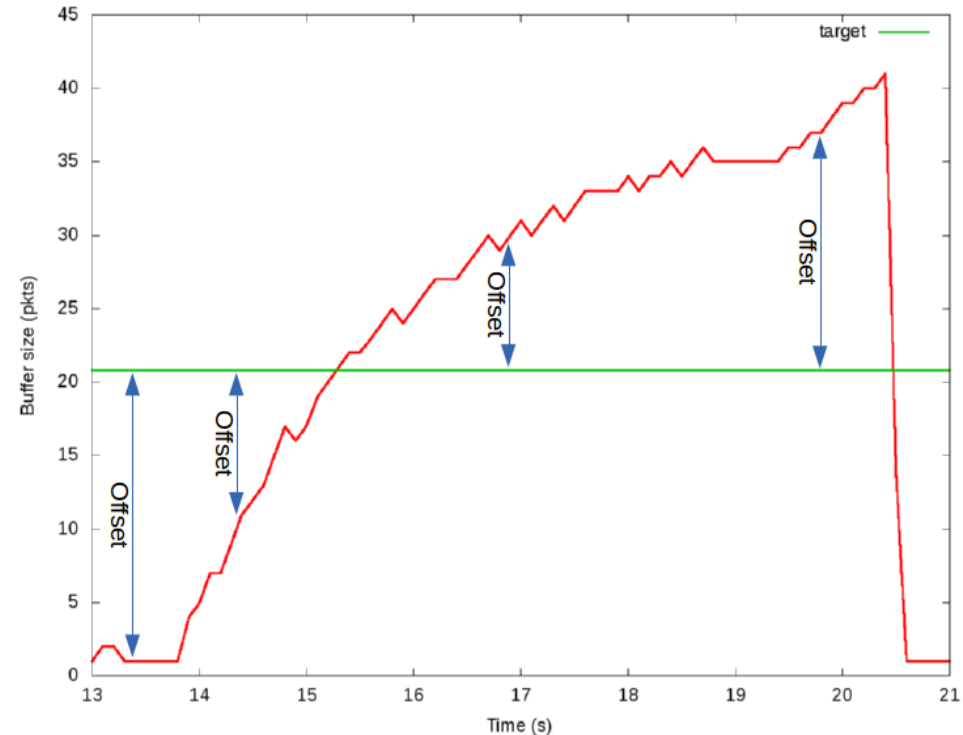
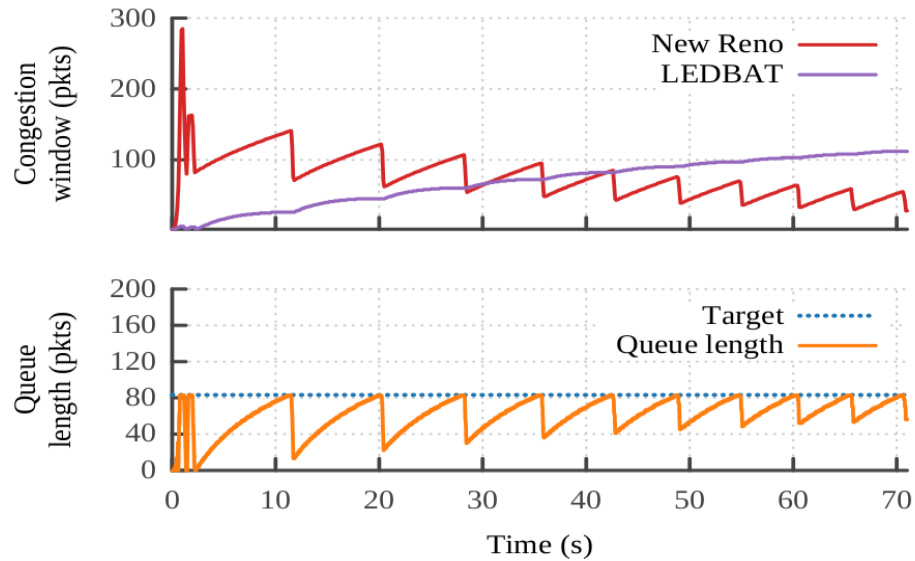
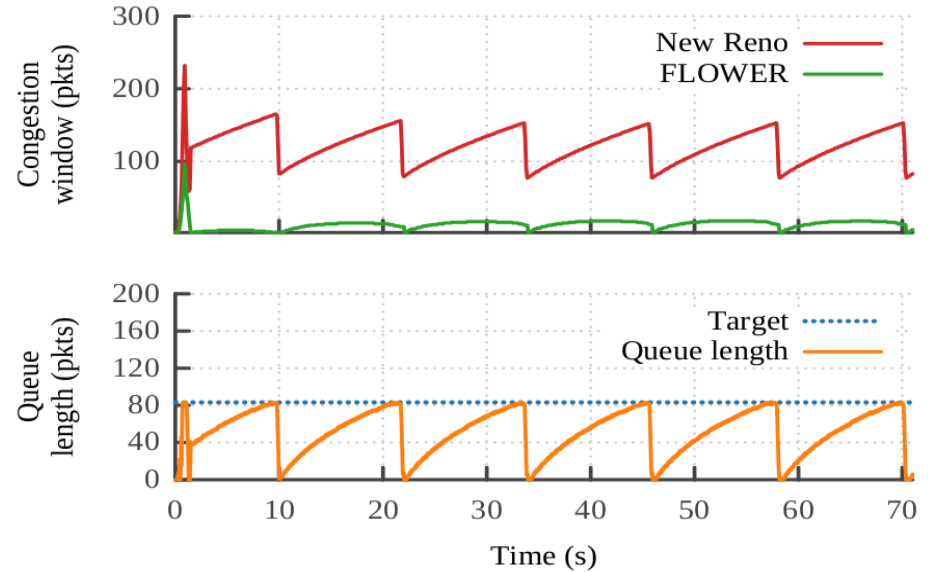


Illustration of FLOWER Behavior



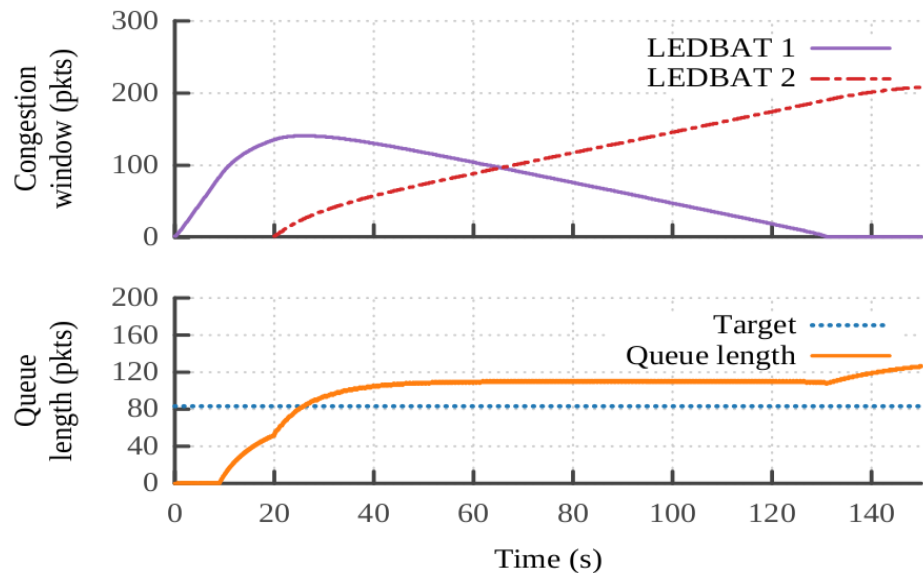
LEDBAT vs. NewReno



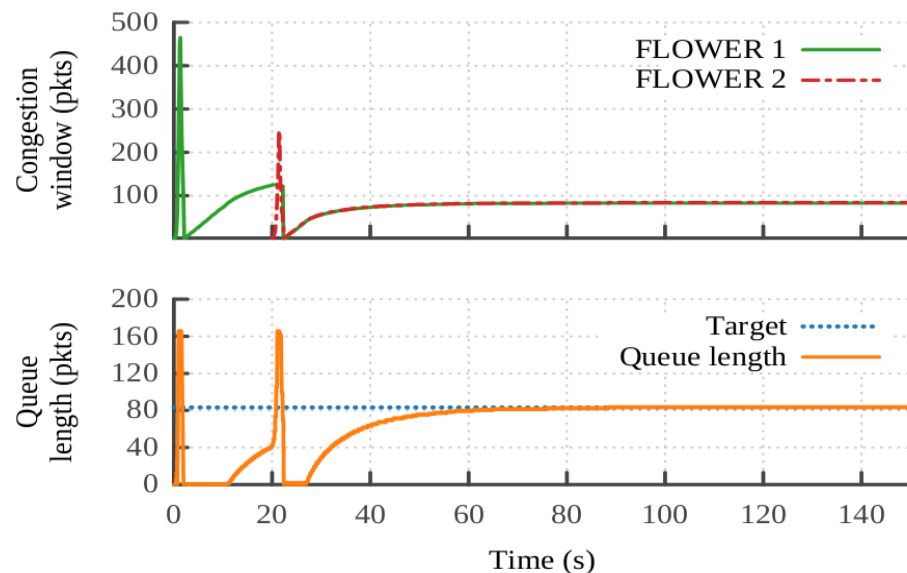
FLOWER vs. NewReno

$C = 10 \text{ Mb/s}$, $Owd = 50 \text{ ms}$, $B = \text{BDP}$

Latecomer Issue



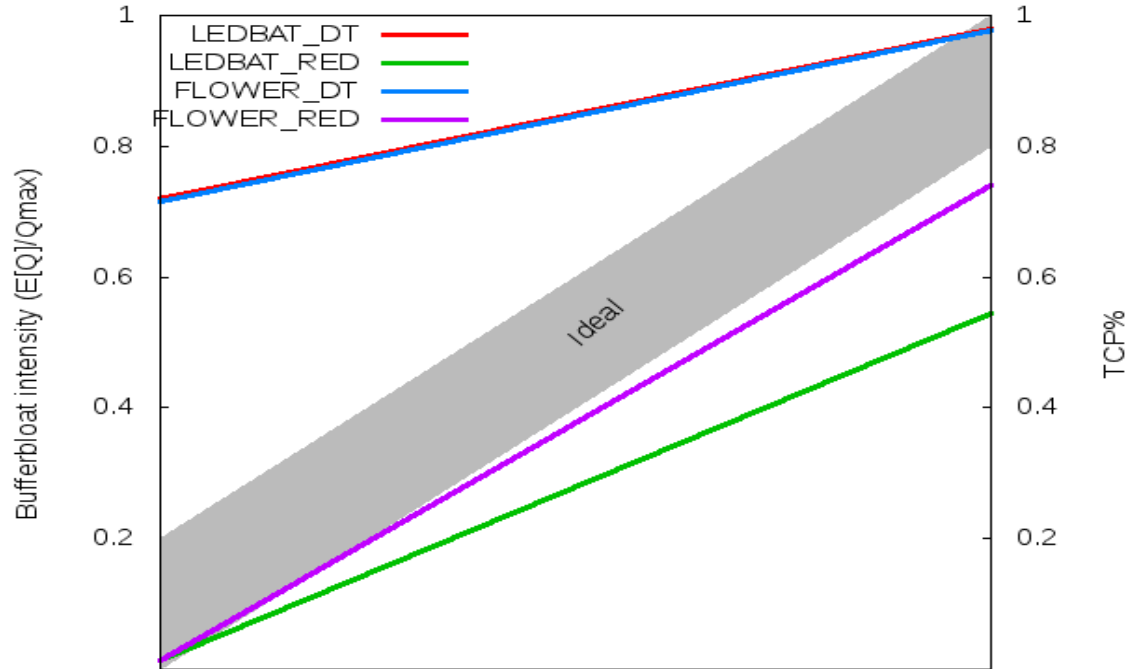
LEDBAT vs. LEDBAT



FLOWER vs. FLOWER

$C = 10 \text{ Mb/s}$, $Owd = 50 \text{ ms}$, $B = \text{BDP}$

Bufferbloat and LBE



Experiment done following Elsevier Com. Network

Y.Gong, D.Rossi, C.Testa, S.Valenti, M.D.Taht,

“Fighting the bufferbloat: on the coexistence of AQM and low priority congestion control”

Conclusions

- LEDBAT tuning is very difficult and highly depends on the network condition
- Implementation in Linux kernel in progress
 - Low computational complexity
- Possibility for a more robust controller: a Neuro-Fuzzy controller
- Novel LBE proposals should consider the impact of AQM
- More details in S. Q. V. Trang et al., “FLOWER – Fuzzy Lower-than-Best-Effort Transport Protocol”, IEEE LCN 2015