A framework to determine the optimal loss rate of RED queue for next generation Internet routers

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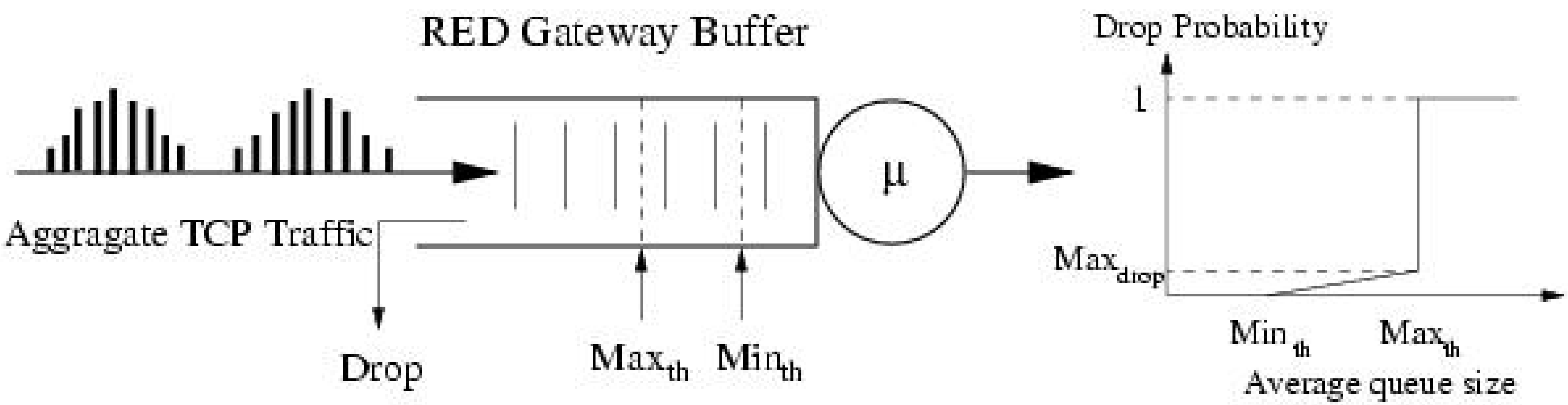
Queue Management

- Passive
  - No preventive packet drop until buffer reaches a threshold when packets are dropped with probability of one.
  - Examples:
    - Tail Drop
    - Drop from Front
    - Pushout
- Active
  - Preventive random packet drop
  - Example: Random Early Detection
  - Suggested by IETF (RFC 2309)

Random Early Detection (RED)

- Uses
  - four parameters: min_th,   max_th,   max_p,   w
  - average queue size (*avg)* is calculate using a weighted averaging
  - Drop probability, $p = \max_p \dfrac{avg - \min_{th}}{\max_{th} - \min_{th}}$
- Solves
  - Global synchronization problem
  - Avoids bias against bursty traffic



RED Algorithm

For Each Packet Arrival

Calculate the average queue size avg

If Min_Threshold $\leq$ avg <Max_Threshold

Calculate probability p

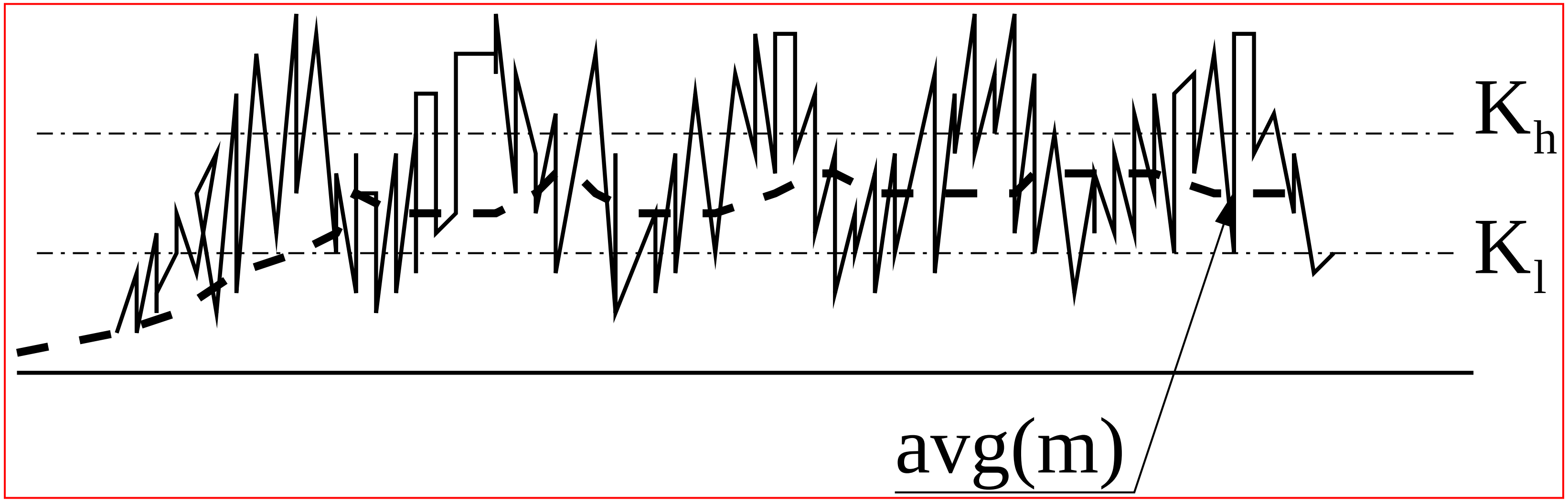
with probability p:

Mark the arriving packet

else if Max_Threshold $\leq$ avg

Mark the arriving packet

Average and Instantaneous Queue Lengths

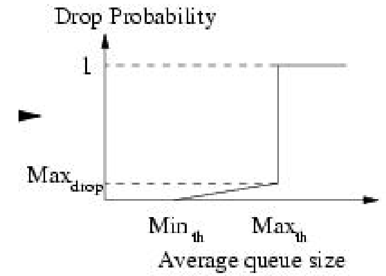


Kh = *max_th*,

Kl = *min_th*

Value of *max_p*

- *max_p* is too small:
  - RED is insufficient to notify senders,
    - Tail drop will dominate
- *max_p* is too large:
  - Low link utilization



- Open Question: What is the optimum value of *max_p?*

Problem statement

- Value of *max_p* suggested in previous research
  - Takes into account only the packet drop rate, but does not take into account the traffic pattern.
- Open question:
  - What is the optimum value of *max_p?*
  - What is the relationship between *max_p* and the other three parameters?

Objectives

$$p = \max_p \frac{avg - \min_{th}}{\max_{th} - \min_{th}}$$

- Develop a model for *max_p* which is related to:
  - TCP connection parameters and
  - RED configuration parameters
- The *max_p* suggested by our model:
  - Results in packet drops being due to active drops
  - Eliminates tail drops (passive drops)
  - Results in high link utilization
  - No global synchronization
- Previous value of *max_p* in literature
  - Eliminates passive drops
  - But, results in low utilization of the link bandwidth for TCP traffic.

Model

- Change in instantaneous queue depends on the difference between incoming and outgoing traffic rates to the queue.
  - Incoming traffic rate depends on the size of the TCP congestion window and the round trip time.
  - Model for *cwnd* has been developed in previous research.

N=Number of connections

C=constant depending of the TCP settings.

μ= Service rate of RED queue

τ = RTT in terms of calculation interval of average queue length.

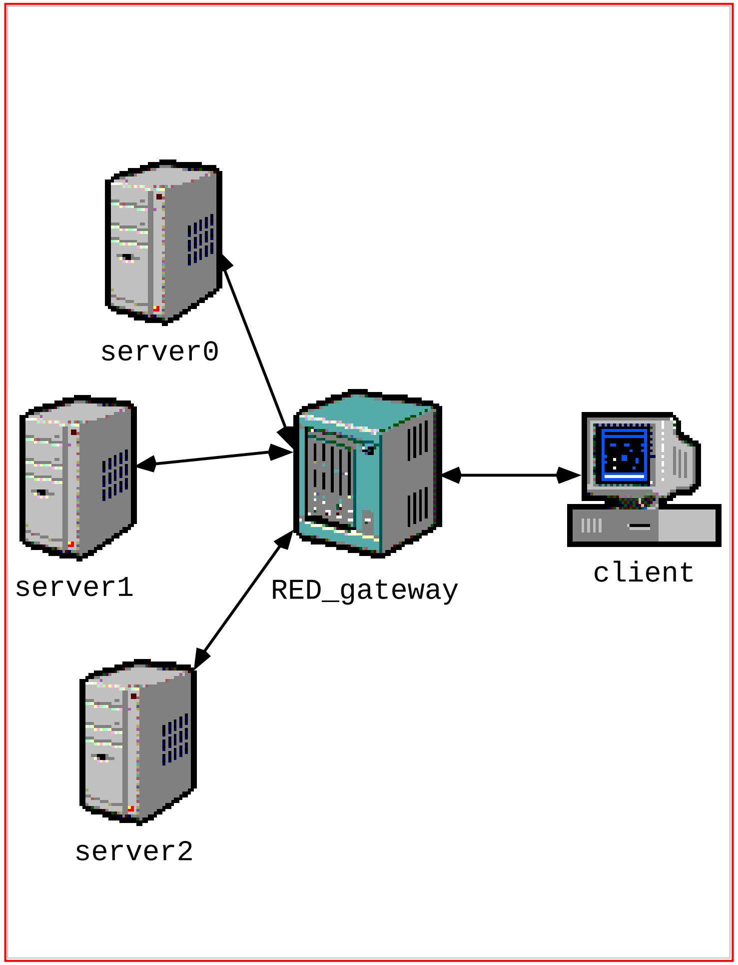
$$\frac{(NC)^2 (K_h - K_l)(1+\frac{K_l}{2K_l})^2}{(\mu\tau)^2 K_h} \le \max_p \le \frac{(NC)^2 (K_h - K_l)(1+\frac{K_l}{2K_l})^2}{(\mu\tau)^2 K_l}$$

Simulation Configuration

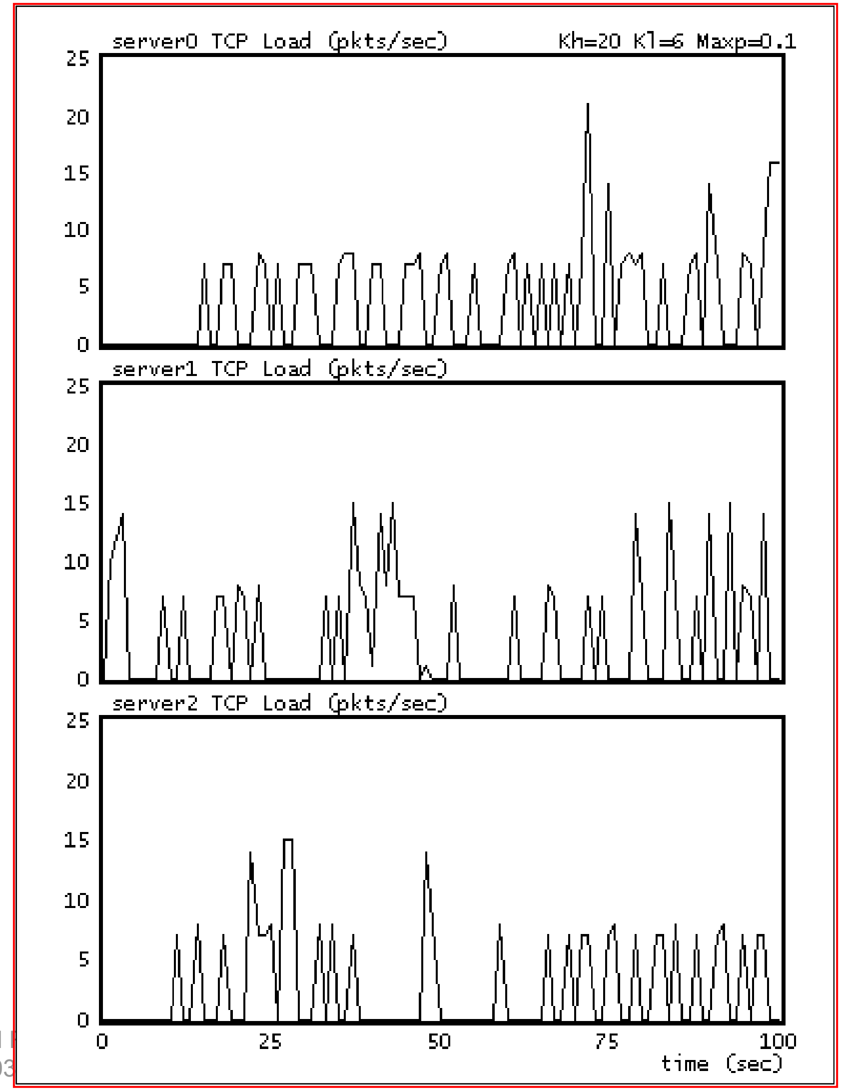
Serv 0 → RED: 1ms, 100 Mbps
Serv 1 → RED: 5ms, 100 Mbps
Serv 2 → RED:31ms, 100 Mbps
Client → RED: 5ms, 10 Mbps
w=0.07

$K_l^0 = 6, K_h^0 = 20$

$K_l^0 = 6, K_h^0 = 140$



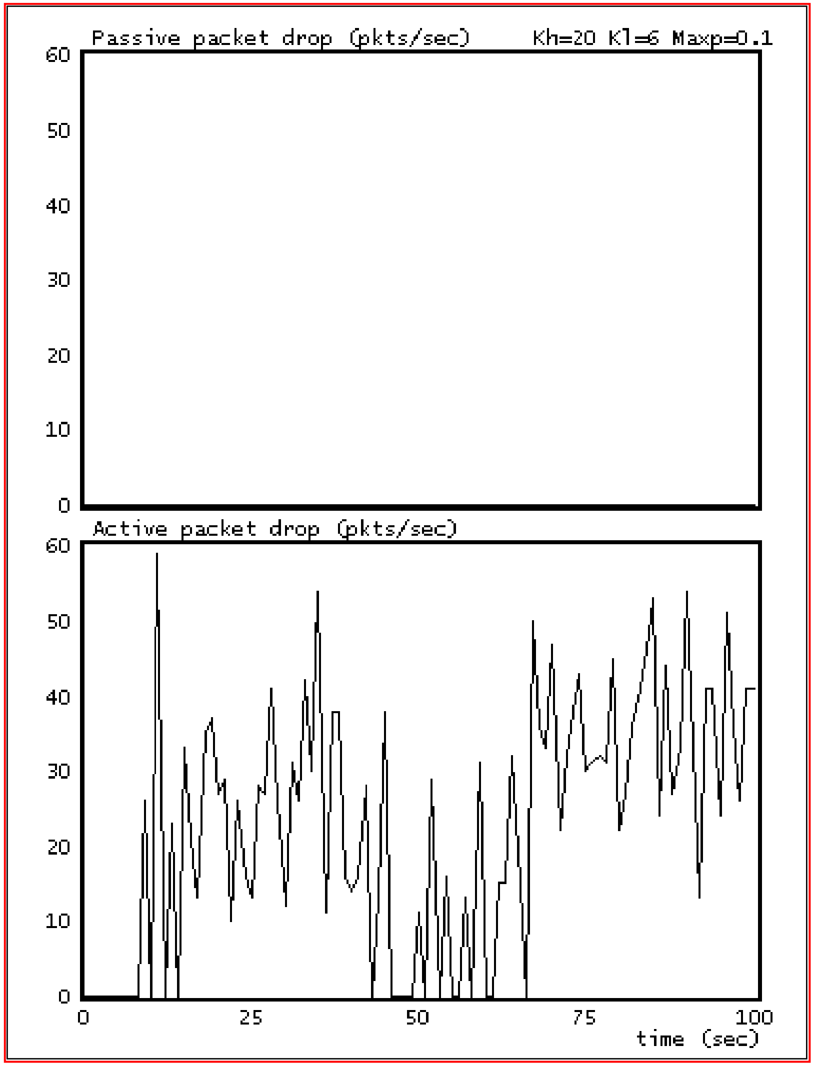
TCP Load – Typical RED parameters



- No global synchronization.
- This is expected.

Packet drop - Typical RED parameters

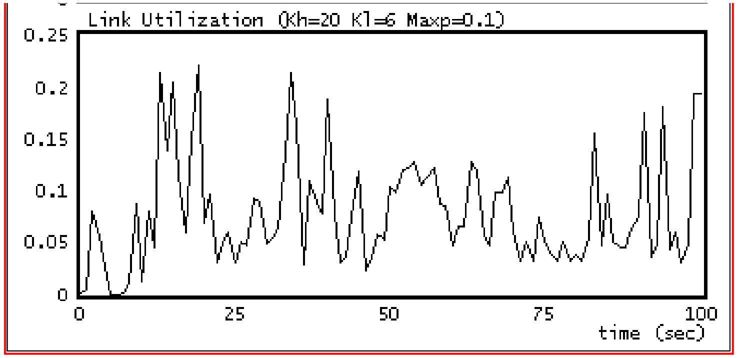
- No passive drops
- All drops due to active drops
- This is expected



Link utilization - Typical RED parameters

Typical RED parameters

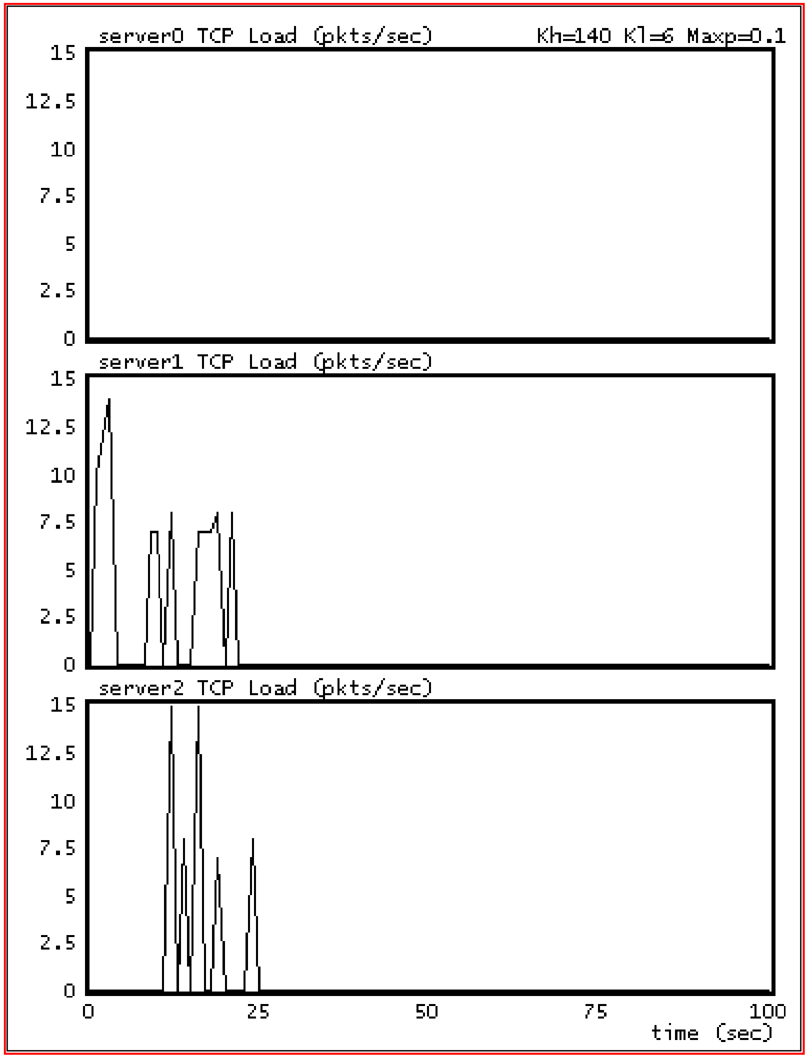
- *Good* link utilization



TCP Load

$K_l^0 = 6, K_h^0 = 140$

$\max\_p = 0.1$

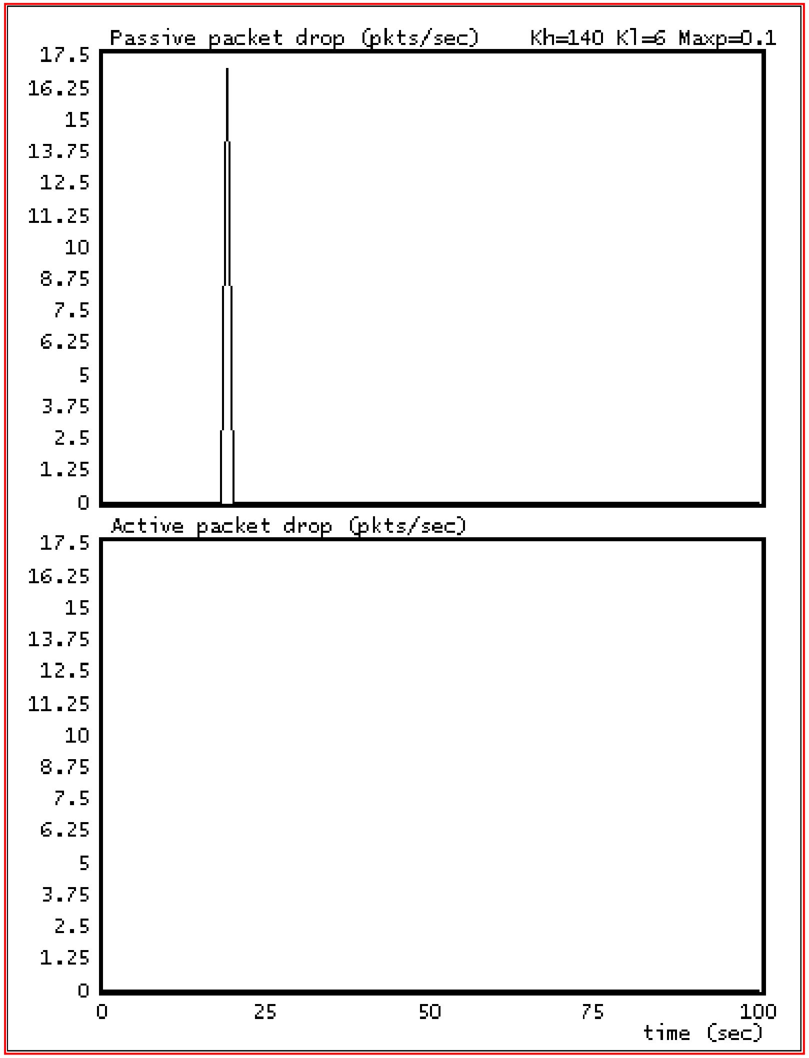


Packet drop

$K_l^0 = 6, K_h^0 = 140$

max_p = 0.1

- Active packet drops taking place

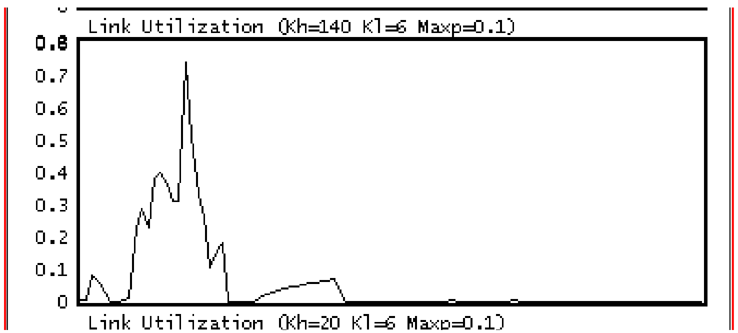


Link utilization

$K_l^0 = 6, K_h^0 = 140$

max_p = 0.1

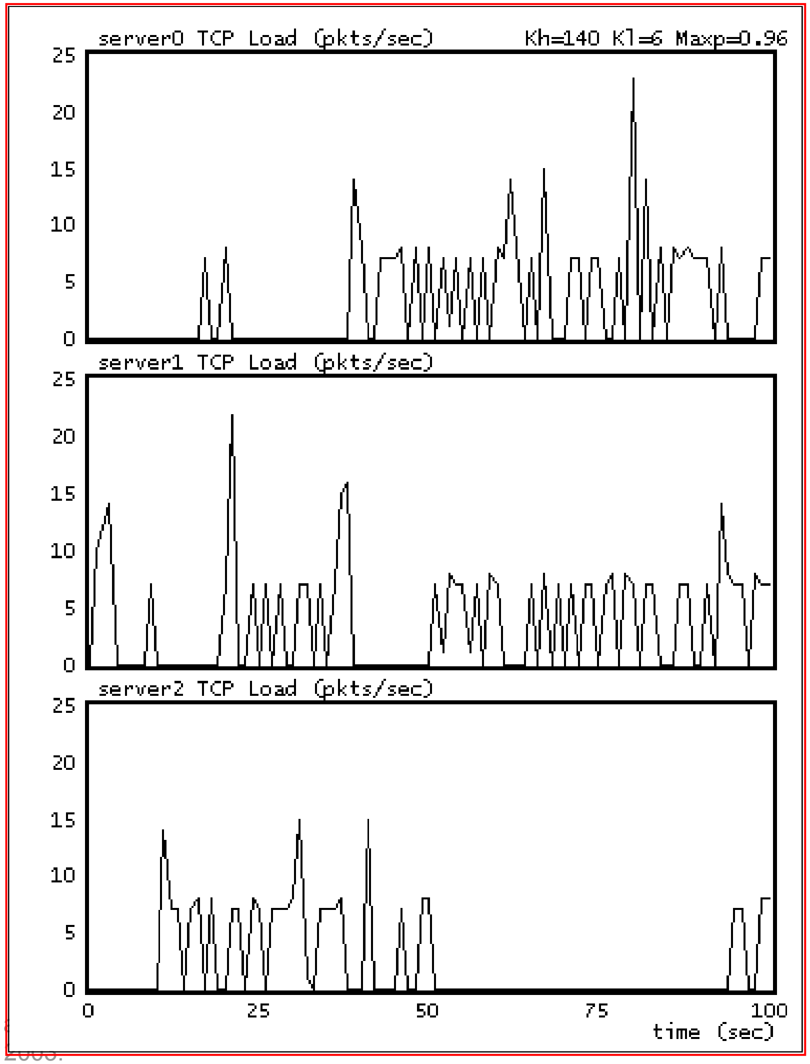
Poor link utilization



TCP Load

$K_l^0 = 6, K_h^0 = 140$

$\max\_p = 0.96$

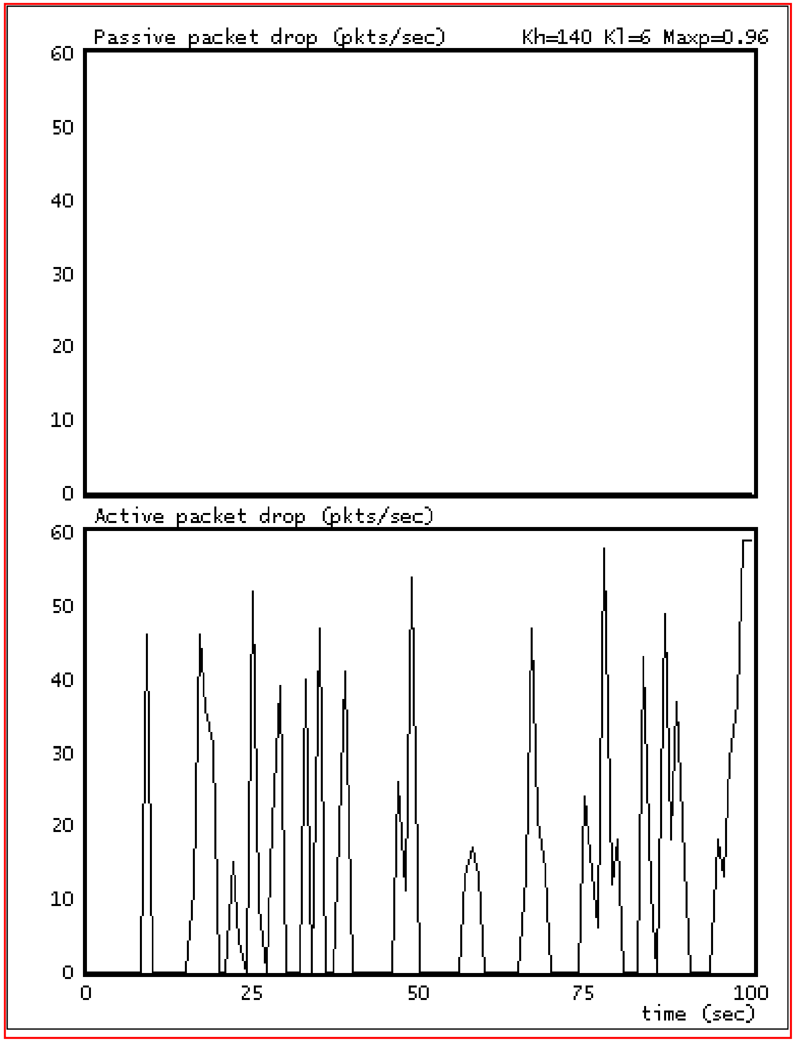


Packet drop

$K_l^0 = 6, K_h^0 = 140$

max_p = 0.96

- All drops are active packet drops

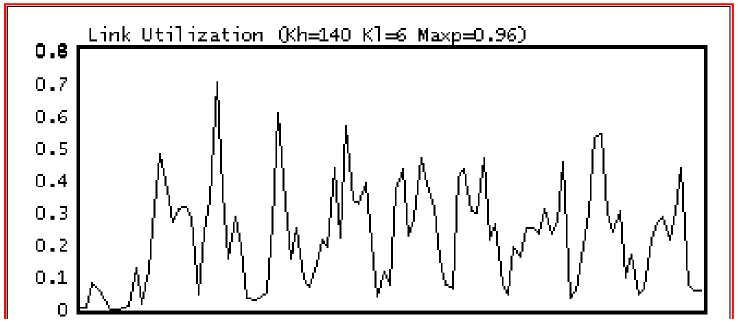


Link utilization

$K_l^0 = 6, K_h^0 = 140$

max_p = 0.96

Good link utilization



Conclusions

- We have proposed a model to calculate *max_p* for RED
- Network engineers can use this value to optimize the performance of routers using RED.

Further Information

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Thank you!

Further Information

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Thank you!