DSRED: Improving Performance of Active Queue Management over Heterogeneous Networks

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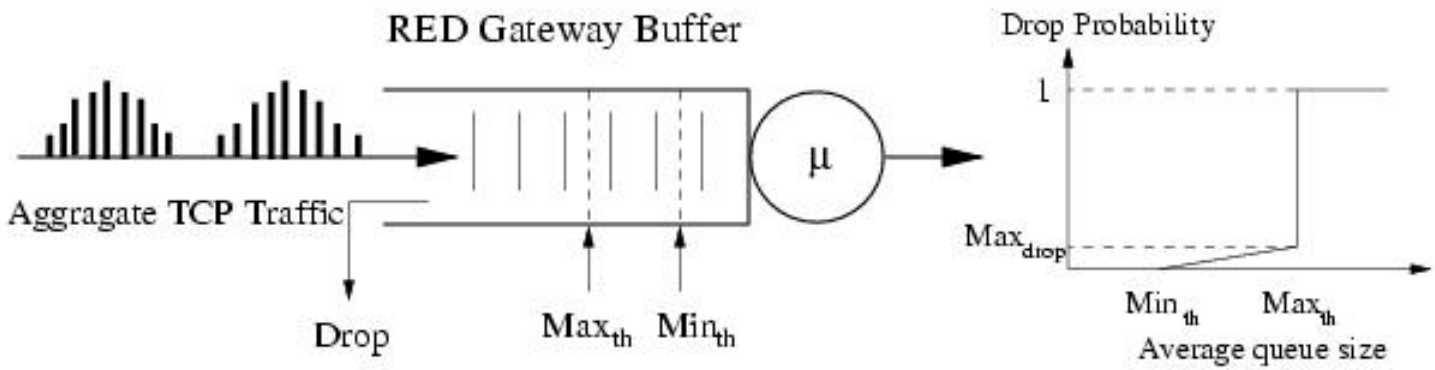
Queue Management

- 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_p, w, max_drop
  - average queue size
- Solves
  - Global synchronization problem

RED


RED Gateway Buffer
Aggragate TCP Traffic
Drop
Max_th
Min_th
μ
Drop Probability
1
Max_drop
Min_th
Max_th
Average queue size

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

Shortcoming of the RED Algorithm

- Low throughput
- Large delay
- Unfairness to connections

Previous work

- RED with aggregate control
  - Stabilized RED (SRED)
  - Random Exponential Marking (REM)
  - Double Slope RED (DSRED)
- RED with per flow accounting
  - Fair RED (FRED)
  - Fair Buffering RED (FBRED)
  - XRED
- RED with class based threshold
  - Class based threshold RED (CBT-RED)
  - Balanced RED (BRED)
  - Stochastic Fair BLUE (SFBLUE)

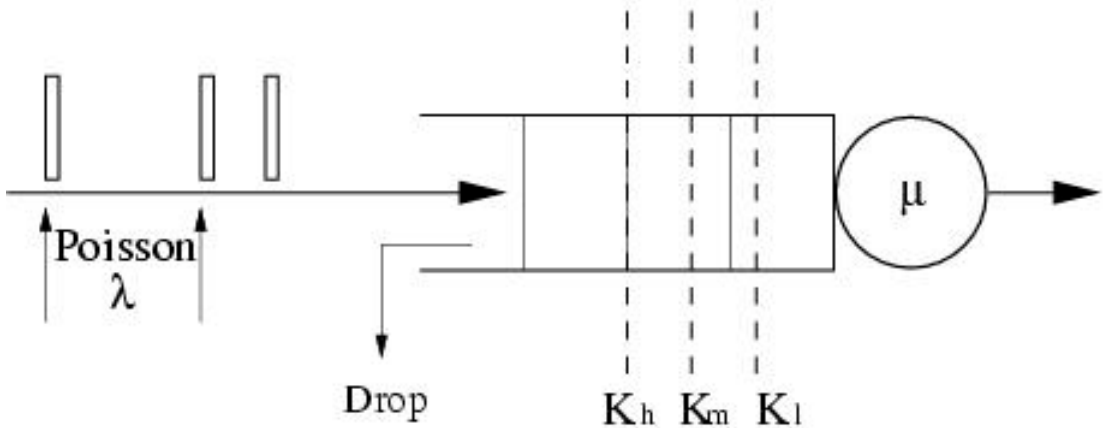
Summary of RED Variants

	Drop Function	Control Variable	Changes from original RED
FRED	Single linear	Per-flow queue length	Per-flow queue length, number of active flow
FBRED	Single linear	Average queue length	Per-flow Max_{drop}
SRED	3 segment step	instantaneous queue length and number of active flow	Step drop function, number of active flows, instantaneous queue
CBT-RED	Single linear	Average queue length	Class based threshold
XRED	Single linear	Average queue length	Priority based drop
BRED	4 segment step	Per-flow queue length and number of active flows	Per-flow queue length, number of active flows, step drop function
DSRED	Two linear	Average queue length	Two linear drop function with different slope,
BLUE	Step function	Link utilization and packet loss	Step increase/decrease function, link rate, packet loss
REM	Exponential function	Link rate mismatch and buffer difference	Exponential function, link rate mismatch and buffer difference
SFB	Step function	Instantaneous queue length	Organize sub-queue in Bloom filter

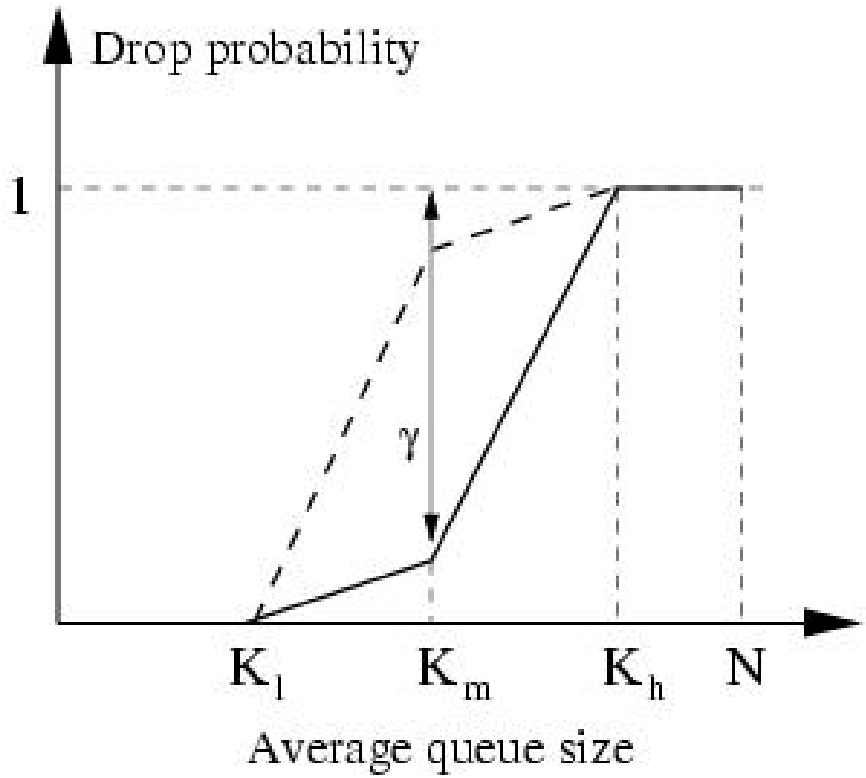
Objective of this work

- Evaluate the performance of DSRED

DSRED



Drop function of DSRED



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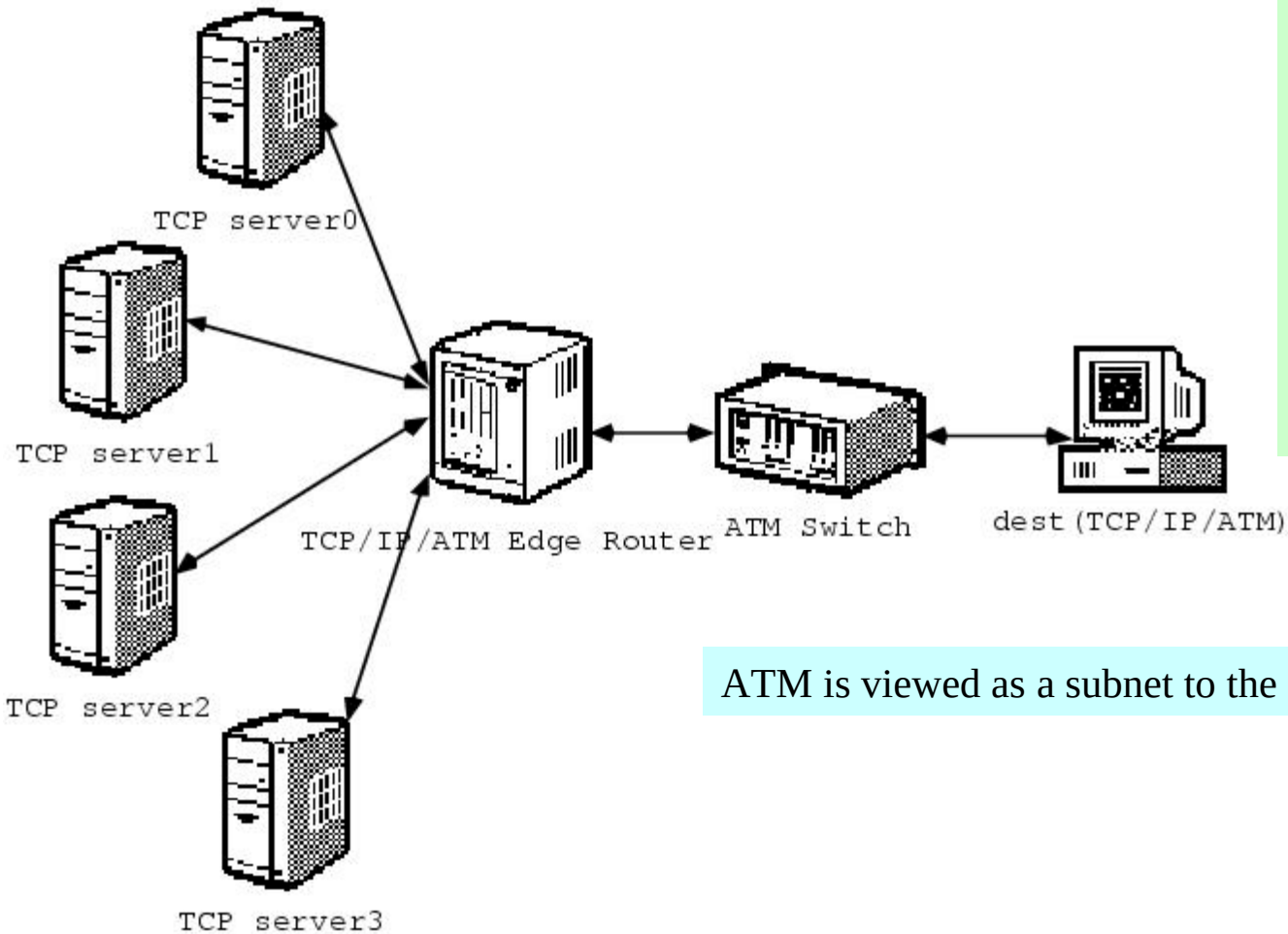
DSRED

$$p_d(avg) = \begin{cases} 0 & avg < K_l \\ \alpha(avg - K_l) & K_l \leq avg < K_m \\ 1 - \gamma + \beta(avg - K_m) & K_m \leq avg < K_h \\ 1 & K_h \leq avg \leq N \end{cases}$$

Simulation Configuration



- Router buffer size = 200 packets.
- K_l=6
- K_h=20
- W=0.07
- Max_drop=0.1
- gamma = 0.96

ATM is viewed as a subnet to the IP network

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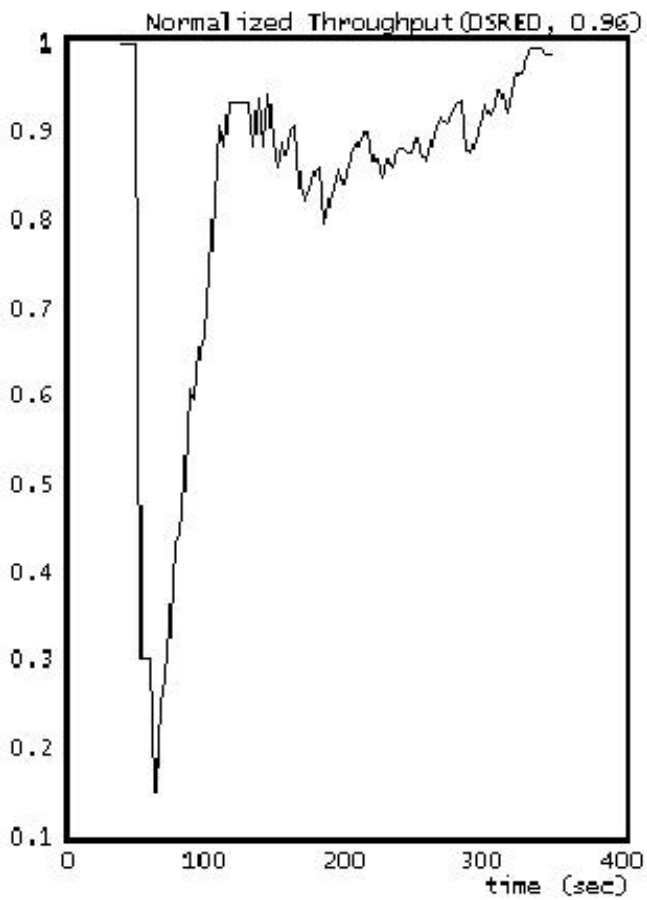
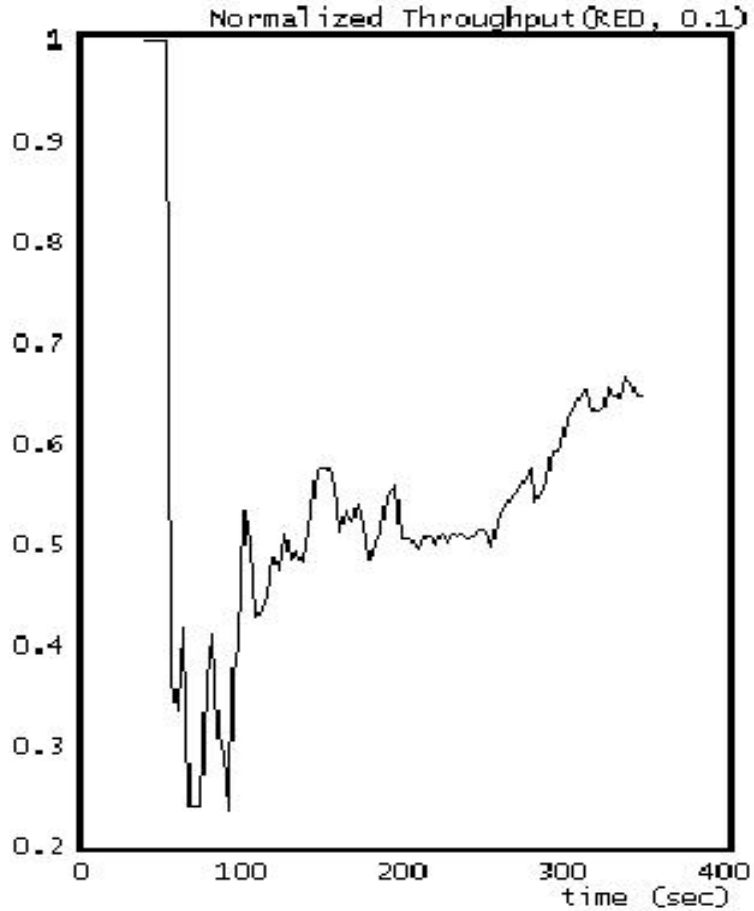
Performance measure

- Comparison of the performance of DSRED and RED
- Performance criteria
  - Throughput
  - Delay
  - Packet drop
  - Queue size
- ATM traffic contracts: best effort service of IP based networks is mapped to the following ATM services (RFC 2382)
  - nrt-CBR
  - UBR

Throughput: nrt-VBR





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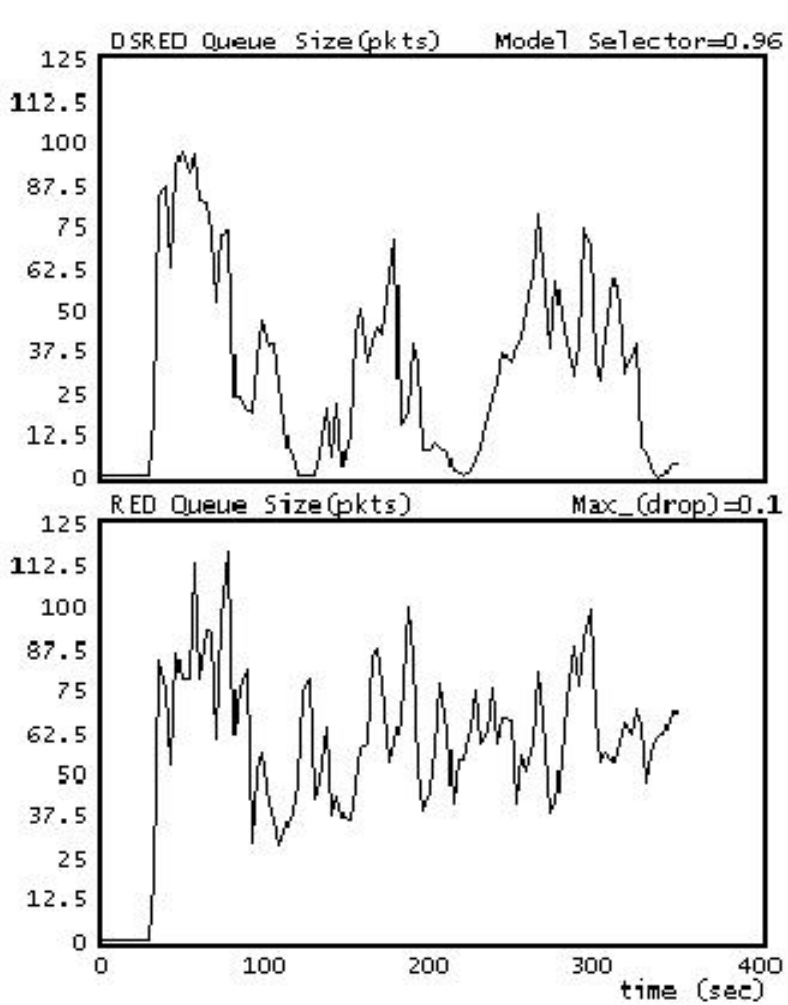
Queue Size: nrt-VBR



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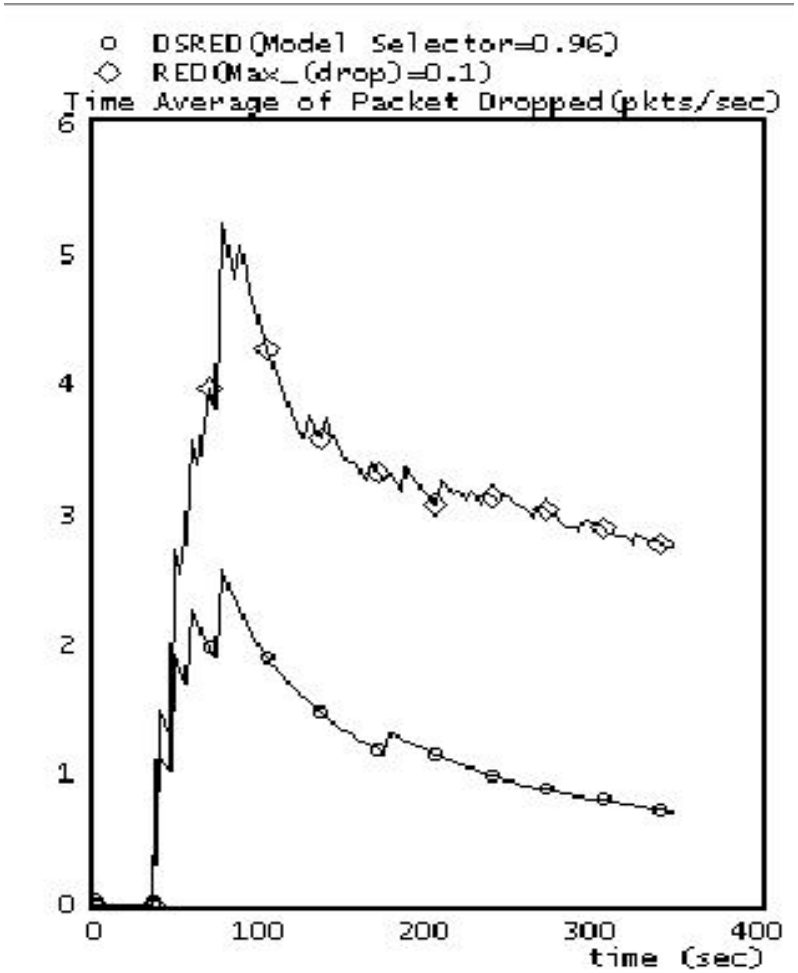
Packet drop: nrt-VBR



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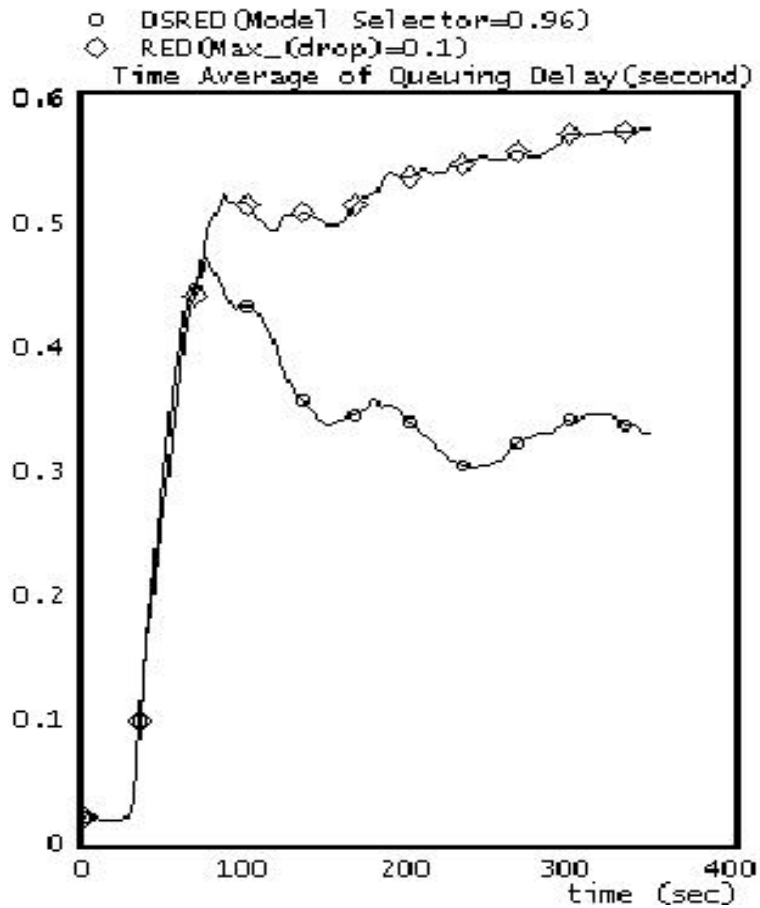
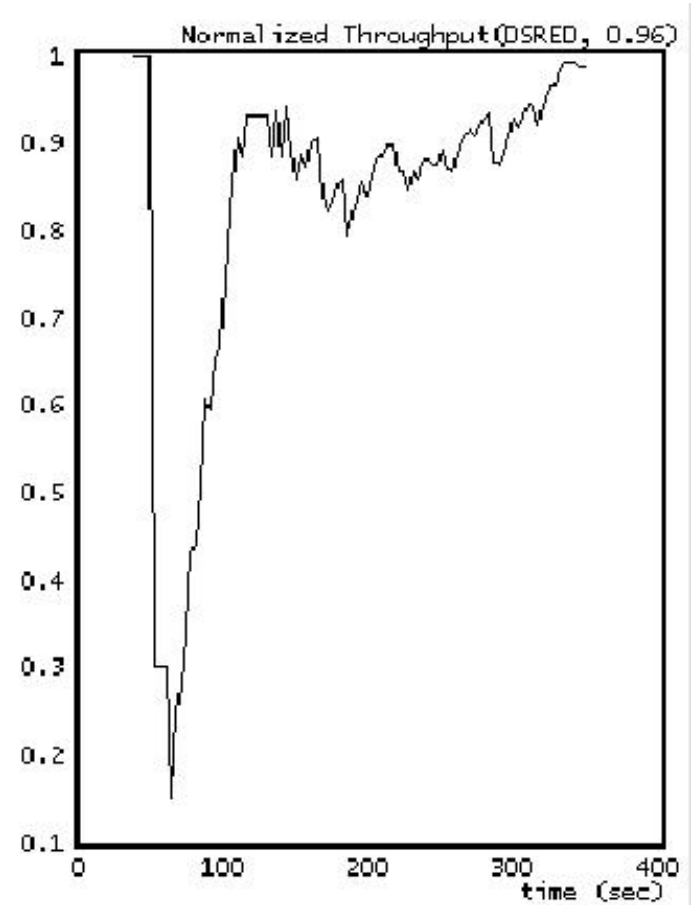
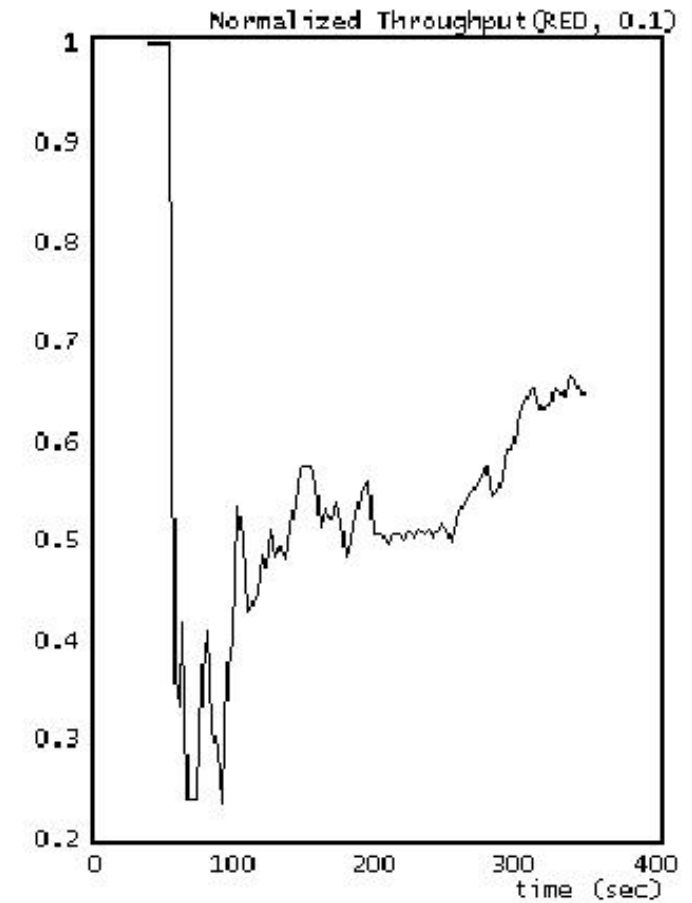
Queuing delay: nrt-VBR

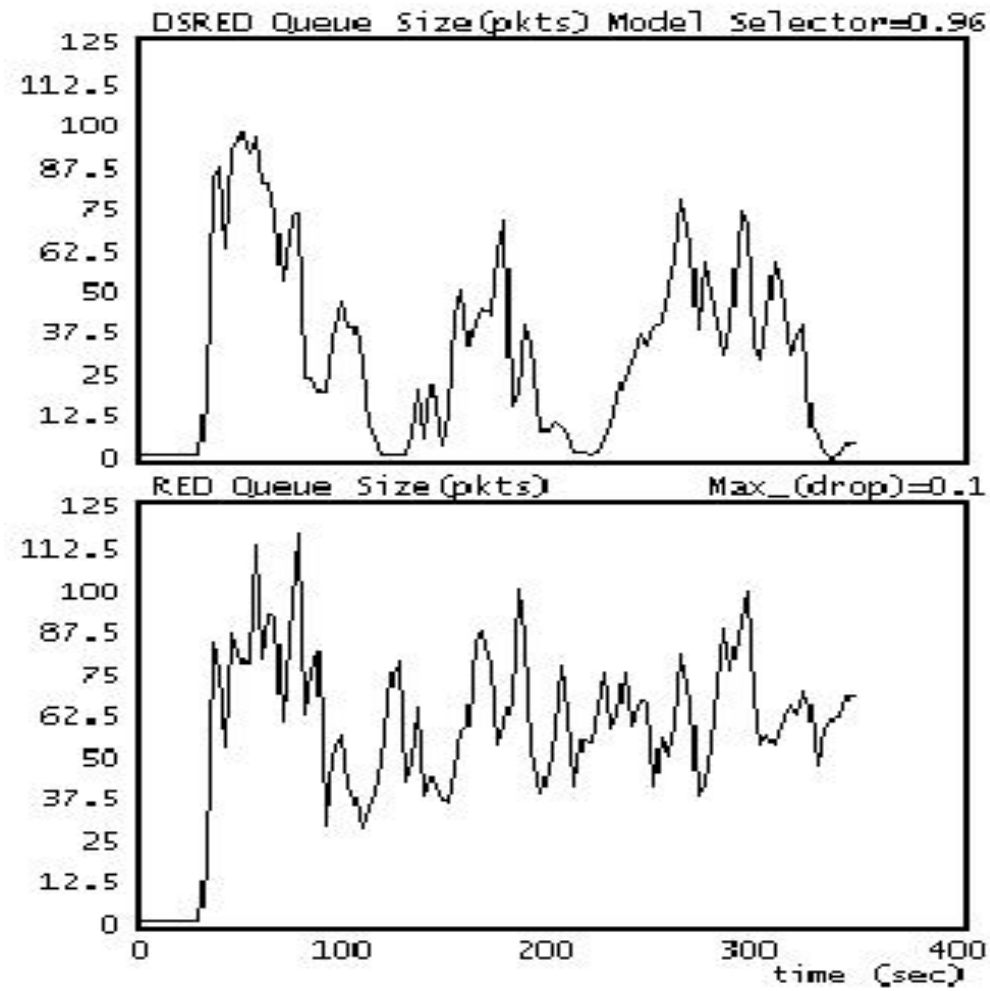


Throughput: UBR





Queue size: UBR



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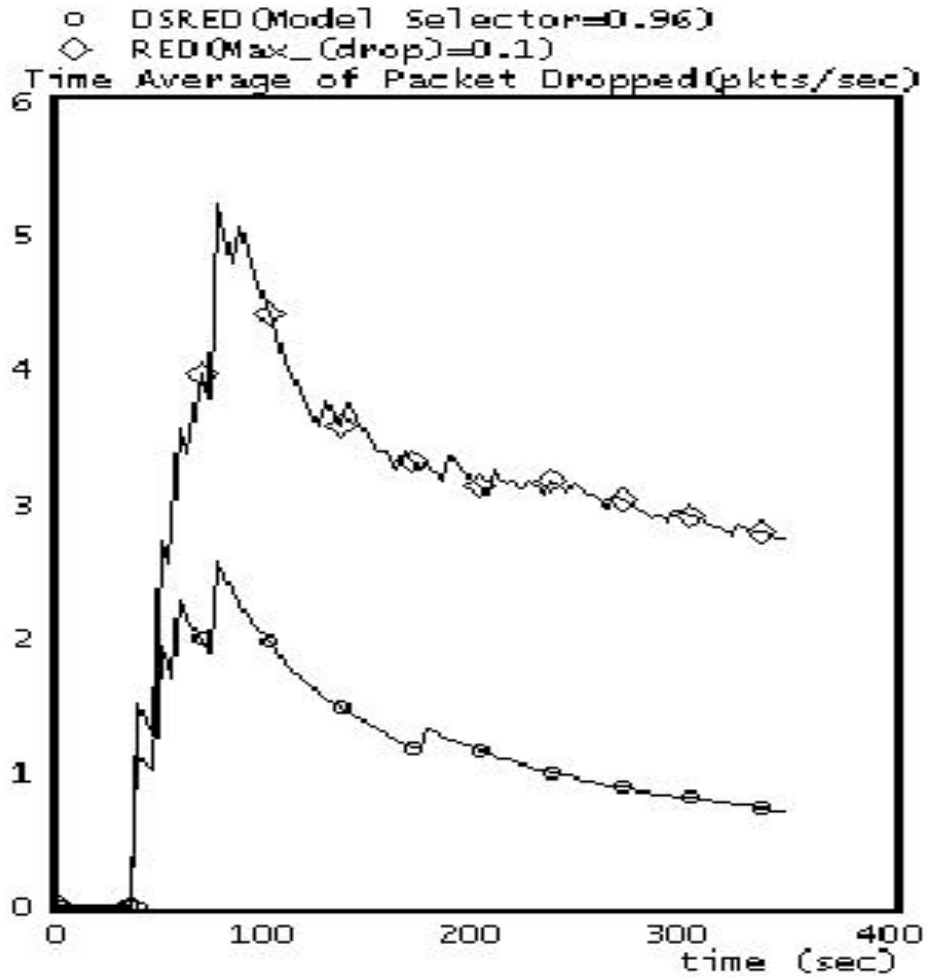
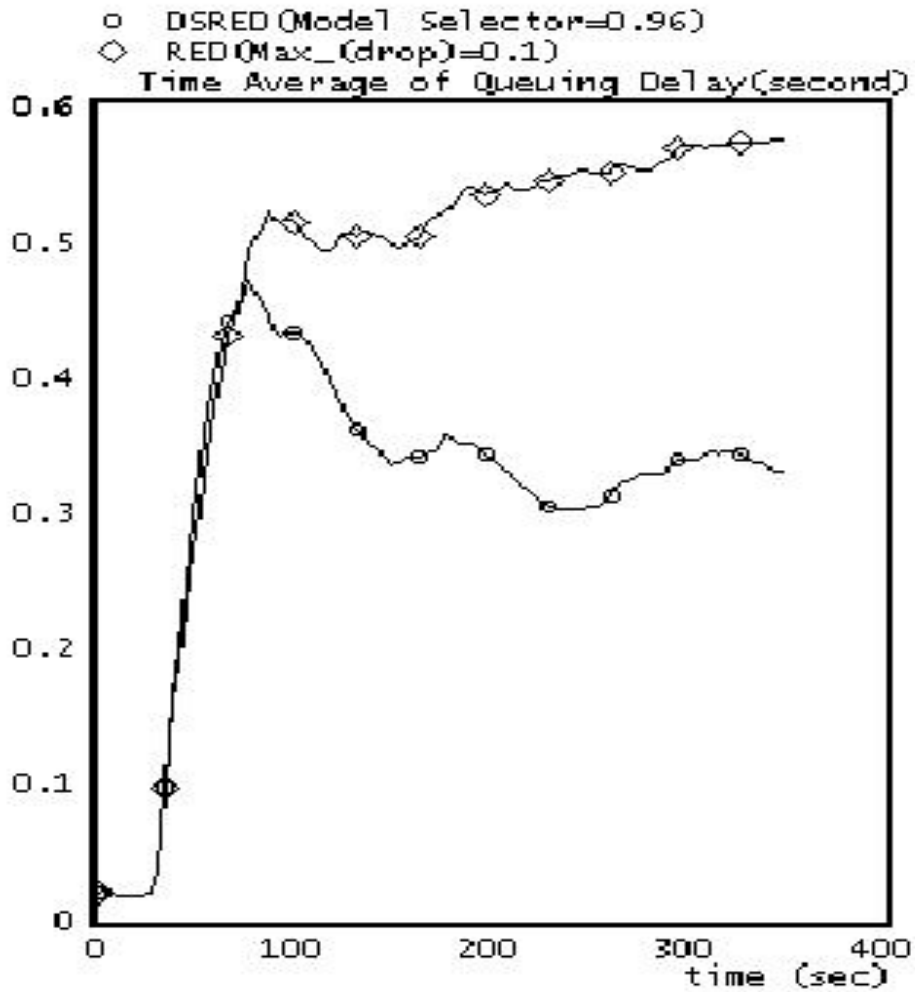
Packet drop: UBR



Queuing delay: UBR



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Conclusion

- Evaluated the performance of DSRED under heterogeneous network environment
- DSRED performs better than RED
- DSRED is robust for different traffic contracts at the edge
- DSRED is suitable for the next generation Internet routers