International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 05 | May-2016 www.irjet.net p-ISSN: 2395-0072

Performance Evaluation Of DropTail and Random Early Detection

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***Abstract:** Buffer sizing is an important network configuration parameter that impacts the quality of data traffic. In today's networks, over-buffering or the 'bufferbloat' problem creates excessive end-to-end delay whereas under-buffering results in frequent packet loss and subsequent under-utilization of resources of the network. To remove the bufferbloat problem, Queue Management Algorithms are proposed. It is classified into two types i.e Passive Queue Management and Active Queue Management. This paper compares passive queue management algorithm DropTail and active queue management algorithm Random Early Detection on the basis of performance factors such as instant throughput, queue loss and end to end delay.* Simulation is done by using Network Simulator (*NS2*) and the graphs are drawn using X-graph. *After comparing techniques DropTail and Random Early Detection using these performance metrics, the simulation results show that end to end delay is less in RED as compared to DropTail, there is no queue loss in DropTail whereas there are queue losses in RED and instant throughput of Droptail is better as compared to RED.*
Keywords: DropTail , Random Early Detection ,Queue Management Algorithms ,NS2

1. Introduction

Bufferbloat is a phenomenon in packet-switched networks, in which excess buffering of packets causes high latency and variation in packet delay (also known as jitter), as well as reducing the overall throughput of the network. The latency consists of three kinds of delays: transmission delay, processing delay and queuing delay. Queuing Delay is the time the network packet spends waiting to be processed or transmitted. This time obviously depends on the queue size which can grow huge in the case of the bufferbloat. The reason of this growth is congestion in the network. Congestion is a situation in communication networks in which too many packets are present in a part of the subnet leads to performance degradation. Congestion in a network may occur when the load on the network *(i.e.* the number of packets sent to the network) is greater than the capacity of the network *(i.e.* the number of packets a network can handle.).In other words when too much traffic is offered, congestion sets in and performance degrades sharply.

Paths between communicating endpoints are typically made up of many hops with links of different bandwidth. In the fast-to-slow transition hops we can have the situation when there are packets arrived to be queued or dropped, because they can not be immediately transmitted due to the previous arrivals being not processed (passed to the next hop) yet. In packet-switched networks, packets move in and out of the buffers and queues of switching devices as they traverse the network. Buffers help routers absorb bursts until they can catch up. If traffic is excessive, buffers fill up and new incoming packets are dropped. If the buffers are too big, the packets are not dropped, and the queue grows, as well as the queuing delay. So, it is easy to conclude that in the presence of congestion in the network with excessive buffering the resulting delay can grow very high. To solve this problem called bufferbloat ,Queue Management Algorithms are proposed.

2. Queue Management Algorithms

Queue Management algorithms are used to control and optimize queues. It is needed in networking when several nodes transmit data to a bottleneck link. It is classified into two types i.e Passive Queue Management and Active Queue Management.

2.1 Passive Queue Management Algorithms: In this method, packets are dropped only if the buffer is full. These algorithms are easy to implement in real networks.

2.1.1 Drop-Tail

DropTail is a passive queue management algorithm in which packets are dropped only if the queue is full. The router accepts and forwards all the packets that arrive as long as its buffer space is available for the incoming packets [5]. If a packet arrives and the queue is currently full, the incoming packet will be dropped. The sender eventually detects the packet loss and shrinks its sending window. DropTail is the most widely used queue management algorithm due to its simple implementation and high efficiency. However, there are some disadvantages. First is, the average queue length of passive queue management algorithms is large for a long period of time. Due to this end to end delay become too large. Second is, passive queue management algorithms provides a way of congestion control, but not a way of congestion avoidance. Third is, passive queue management algorithms causes the problem of global synchronization and lock-out.

2.2 Active Queue Management Algorithms: To avoid congestion and lock-out, active queue management algorithms are proposed. These algorithms begin to control the queue length before the buffer getting full. Active Queue Management algorithms reduce the average queue length of buffer. Therefore, end to end delay is also reduced as well. Active queue management algorithms such as Random Early Detection (RED) will reduce the problem of global synchronization and lock out , as well as keeping queue sizes down in the face of heavy load and bursty traffic.

2.2.1 RED (Random Early Detection)

RED is an active queue management scheme that provides a mechanism for congestion avoidance. Unlike traditional congestion control schemes that drop packets at the end of full queues, RED uses statistical methods to drop packets in a "probabilistic" way before queues overflow. Dropping packets in this way slows a source down enough to keep the queue steady and reduces the number of packets that would be lost when a queue overflows and a host is transmitting at a high rate. RED makes two important decisions. It decides when to drop packets and what packets to drop. RED keeps track of an average queue size and drops packets when the average queue size grows beyond a defined threshold. The average size is recalculated every time a new packet arrives at the queue. RED makes packet-drop decisions based on two parameters:

- **Minimum threshold (MINIMUMth)**
  Specifies the average queue size *below which* no packets will be dropped.
- **Maximum threshold (MAXIMUMth)**
  Specifies the average queue size *above which* all packets will be dropped.

3.Simulation Setup

We consider the network topology as shown in Fig. 1.The network topology consists of two senders, two receivers and two routers. Duplex link is created between the nodes. Each sender transmits messages to the opposite receiver through the two routers. It is clear that the link between two routers is the bottleneck link of the network. In this scenario only TCP sources are used and TCP packets are being sent to the end of the simulation time. In this topology four TCP Agents (RENO) and 4 FTPs are used. The queue parameter MAXIMUMth is set at three times of MINIMUMth in case of RED.

Consider Bandwidth between nodes and routers=10Mbps,Propagation Delay between nodes and routers=5ms,Propagation Delay between routers=15ms, Round Trip Time =100ms and Packetsize=1000 bytes, Buffer Size=400. We consider three cases of Bandwidth between the routers i.e 0.5Mbps,0.75Mbps and 1.25Mbps to perform the comparison between DropTail and Random Early Detection.

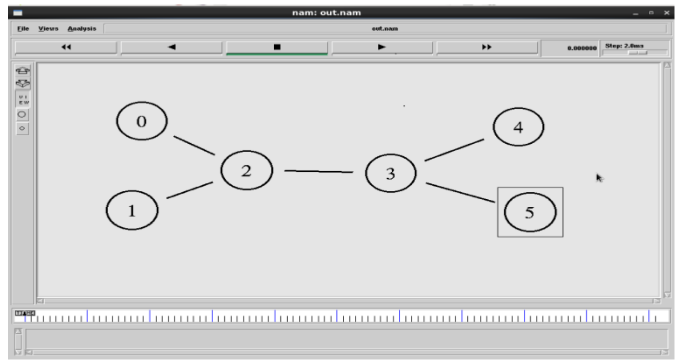


Figure 1 Simulation Topology

4. Performance Parameters

Performance metrics which are used to evaluate the performance are:
1. Instant Throughput: The data (bytes) that can be sent from one TCP sender to a TCP receiver per second during the simulation at different instant of time.
2. Queue Loss : It indicates how many packets are lost from the queue.
3. End-to-end delay: It refers to the time taken for a packet to be transmitted across a network from source to destination.

5.RESULTS

1. Instant Throughput Analysis of DropTail and RED on Bandwidth=0.5Mbps,0.75Mbps,1.25Mbps

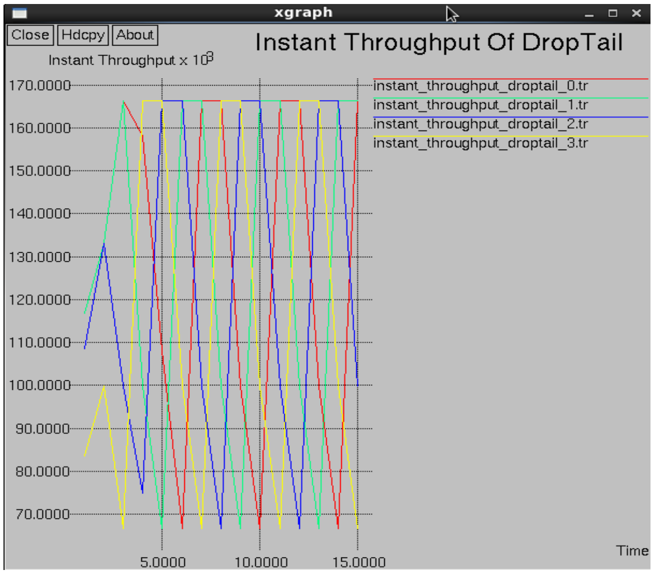


Figure 2 Instant Throughput Of DropTail on BW=0.5Mbps

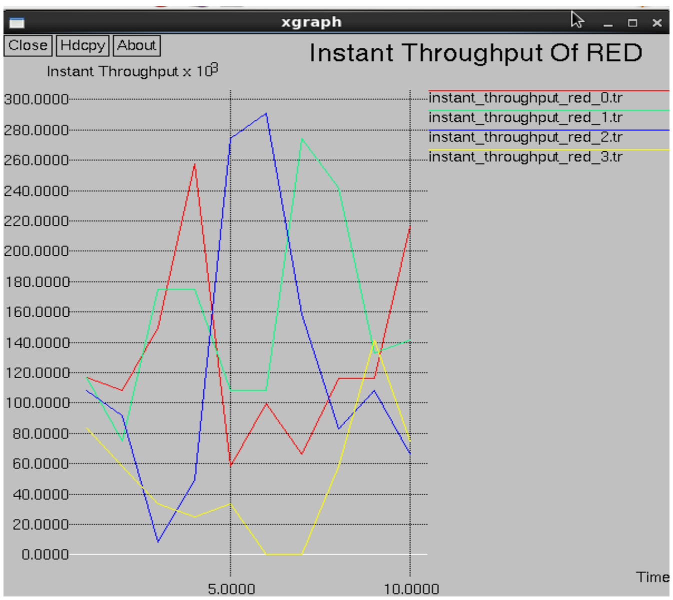


Figure 3 Instant Throughput Of RED on BW=0.5Mbps

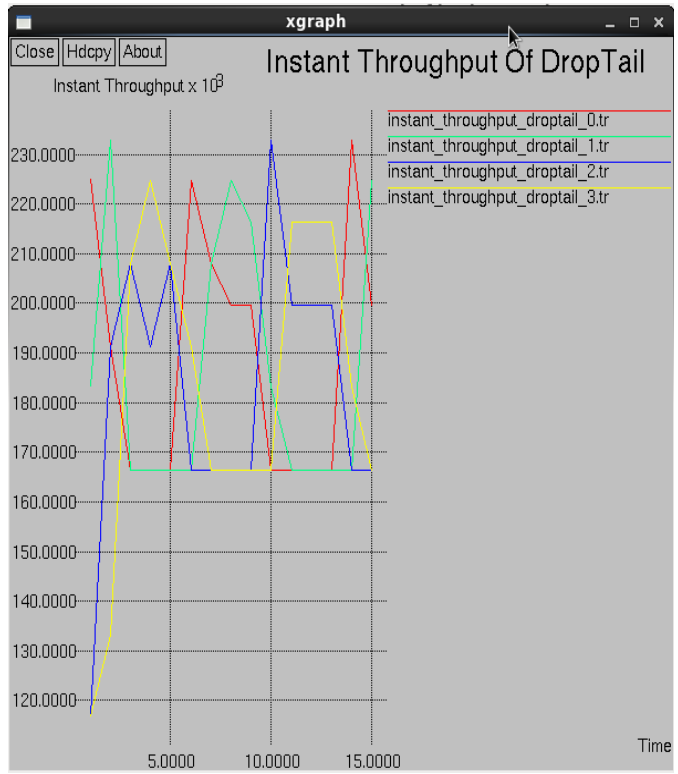


Figure 4 Instant Throughput Of DropTail on BW=0.75Mbps

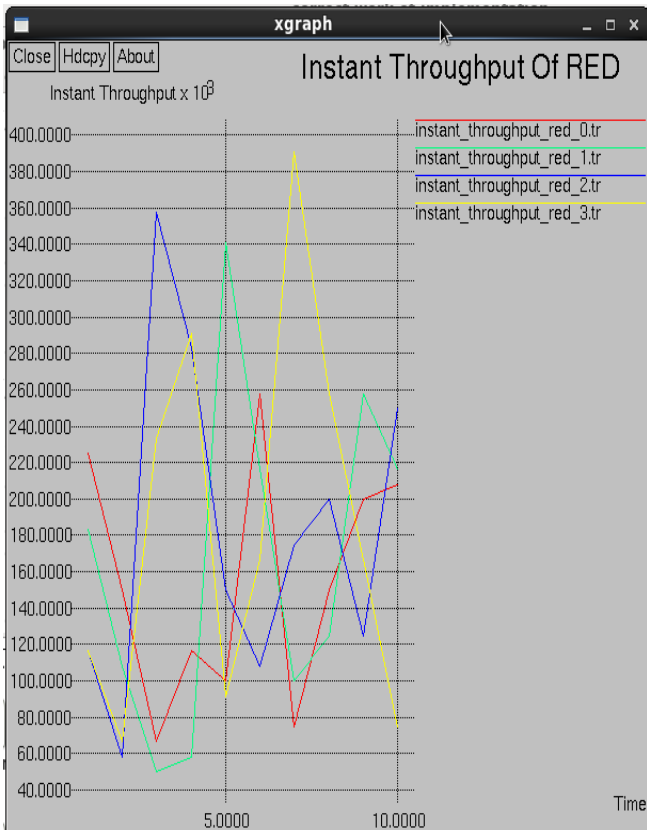


Figure 5 Instant Throughput Of RED on BW=0.75Mbps

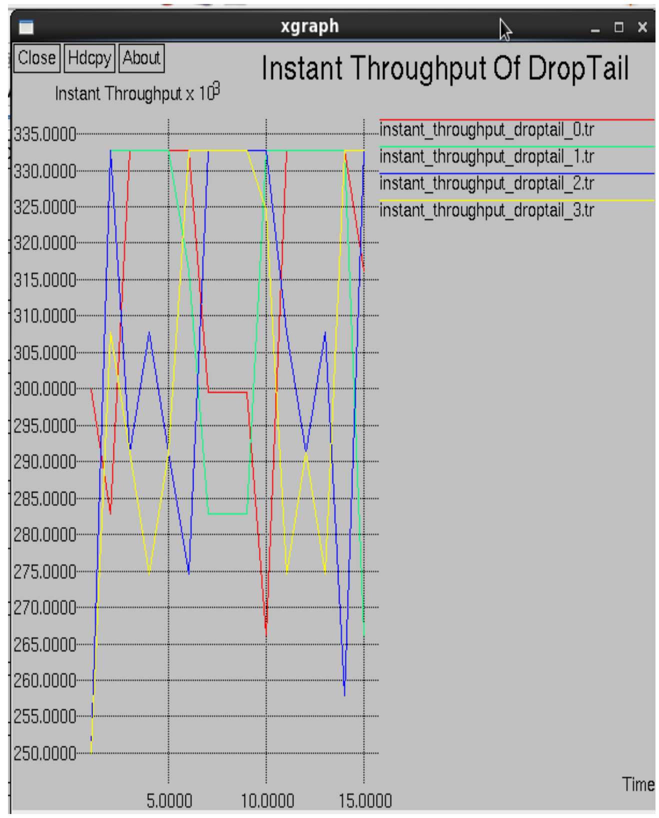


Figure 6 Instant Throughput Of DropTail on BW=1.25Mbps

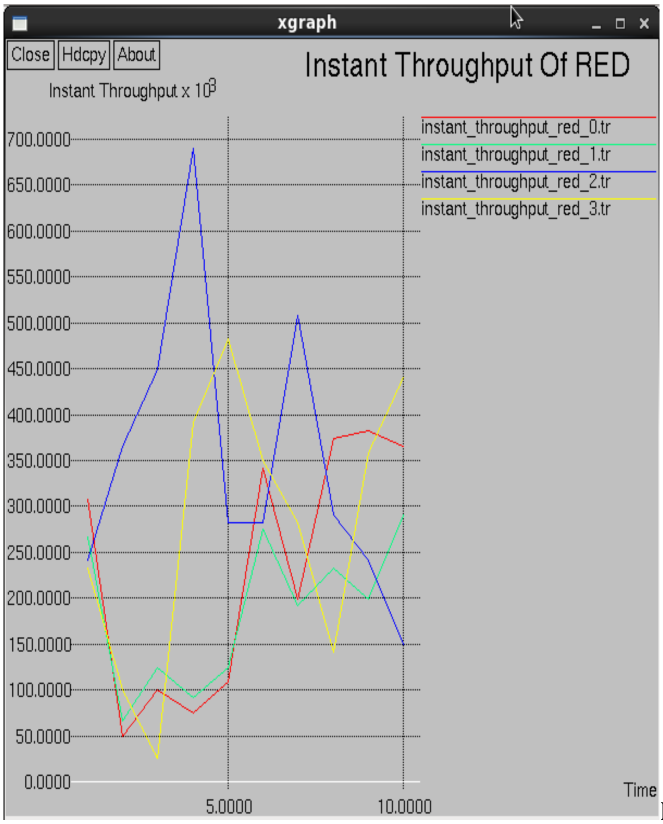


Figure 7 Instant Throughput Of RED on BW=1.25Mbps

Fig.2 To Fig.7 represents variations of instant throughput with time of passive queue management technique DropTail and active queue management technique RED. In case of Bandwidth=0.5 Mbps, 0.75Mbps and 1.25Mbps, the instant throughput of DropTail show more variations i.e move more forward and backward at different instant of time as compared to RED. It is clear from all the X-graphs that DropTail shows large increase in instant throughput as compared to RED.This shows that the instant throughput of Droptail is better than RED.

2. Queue Loss Analysis of DropTail and RED on Bandwidth=0.5Mb,0.75Mb,1.25Mb

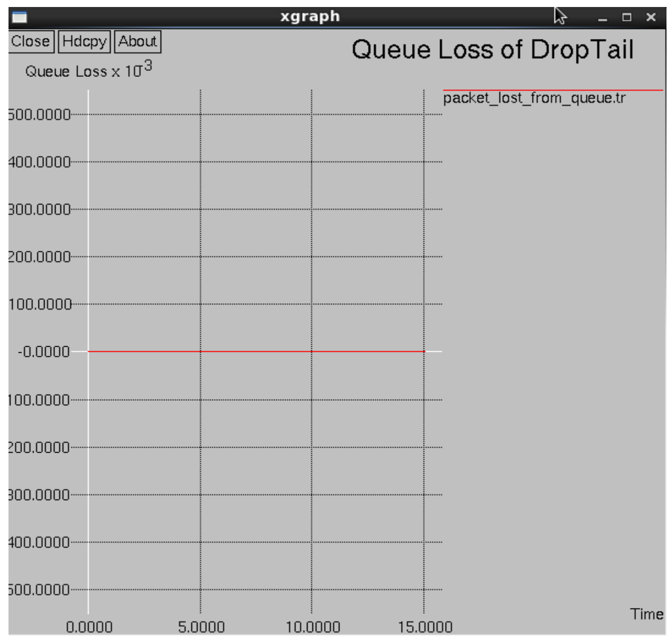


Figure 8 Queue Loss of DropTail on BW=0.5Mbps,0.75Mbps,1.25Mbps

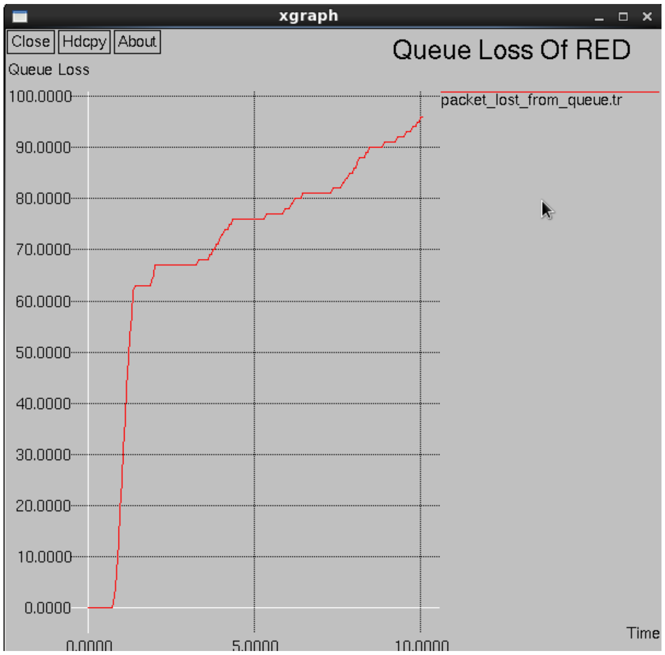


Figure 9 Queue Loss of RED on 0.5Mb

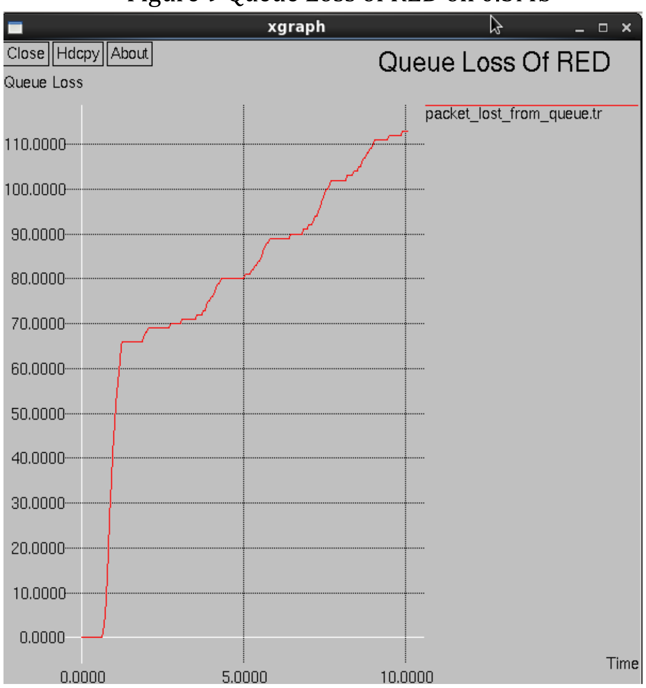


Figure 10 Queue Loss of RED on 0.75Mb

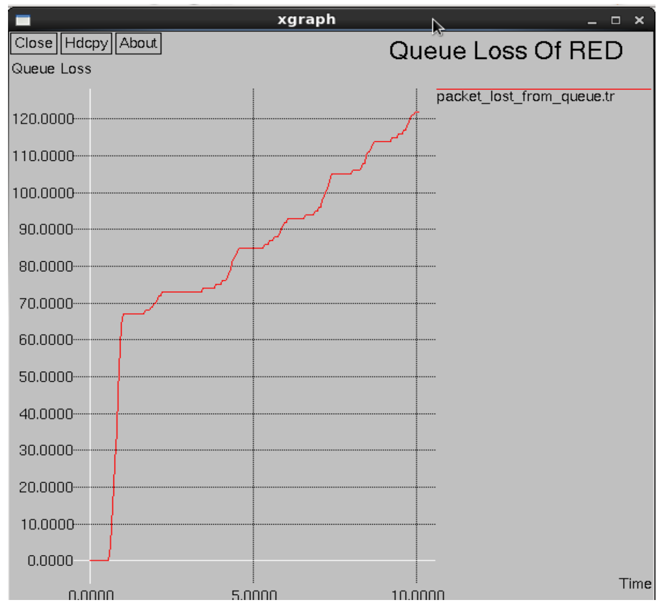
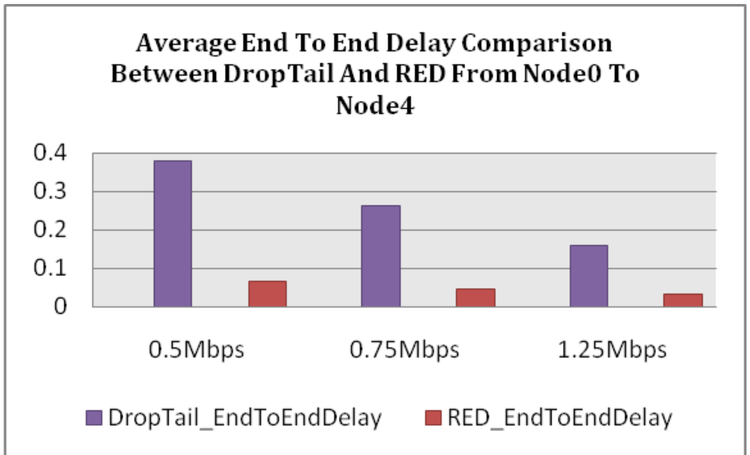


Figure 11 Queue Loss of RED on 1.25Mb

Fig.8 to Fig.11 represents the queue loss of DropTail and RED on BW=0.5Mbps, 0.75Mbps and 1.25Mbps. Fig. 8 represents that there is no queue loss (i.e no packets are lost from the queue) in DropTail whereas Fig. 9 to Fig.11 represents there are queue losses at different instant of time in RED. On BW=0.5Mbps, 0.75Mbps and 1.25Mbps queue loss first increases at a certain level then show slight variations in queue loss in RED i.e packets lost from the queue first increases at a rapid rate and then there are slight variations in packets loss from the queue.

3. Average end to end delay analysis : Average end to end delay of DropTail and RED is calculated on Bandwidth=0.5Mb,0.75Mb and 1.25Mb using awk script file with ns2 simulator is shown in Table1 and its graphs are shown in Fig.12.

Average End To End Delay Comparison Between DropTail and RED from Node0 To Node 4		
Bandwidth	**Droptail_EndToEndDelay**	**RED_EndToEndDelay**
0.5Mbps	0.378952	0.067147
0.75Mbps	0.262309	0.0465646
1.25Mbps	0.160681	0.0335275
Average End To End Delay Comparison Between DropTail and RED from Node1 To Node 5		
Bandwidth	**Droptail_EndToEndDelay**	**RED_EndToEndDelay**
0.5Mbps	0.382079	0.0633303
0.75Mbps	0.266139	0.04369
1.25Mbps	0.161378	0.0339419



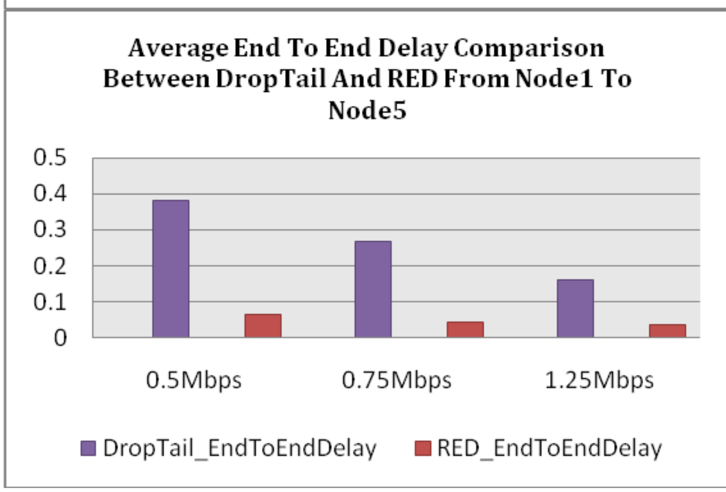


Fig.12 Average End To End delay Comparison between DropTail and RED from node0 to node4 & node1 to node5

It is observed from the table1 and Fig.12 that end to end delay is more of Droptail as compared to RED.

6. Conclusion

We have compared the performance of DropTail and Random Early detection using performance factors like instant throughput, queue loss and end to end delay with ns2 simulator. After analysis of all the graphs,it is concluded that the instant throughput of Droptail is better than RED. There are no packets lost from the queue in Droptail whereas there is more packet drop rate in RED.It is also observed that end to end delay is less in RED as compared to DropTail, therefore RED reduces the problem of bufferbloat. It is concluded that in terms of high instant throughput and no packet loss,Droptail is better as compared to RED. Whereas in terms of reducing average end to end delay RED is better as compared to Droptail.

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