Performance Evaluation Of Queue Management Schemes Of Wireless Network Using NS-2

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Abstract

In packet switched networks, such as Transmission Control Protocol/Internet Protocol (TCP/IP) networks, data from the source travels through a number of intermediate nodes to reach the destination node. If the service rate at the intermediate nodes is less than the arrival rate of the packets, then the packets are queued in a buffer at the intermediate nodes. In practice, since the buffer's size is finite, packets may be dropped or experience high queuing delays. This phenomenon of congestion is detrimental to the performance of the network. TCP sources decrease their packet sending rates when packets are dropped. If the intermediate nodes drop packets only when their queues are full (Drop Tail technique), then it would cause global synchronization between the TCP flows. Furthermore, they would not be able to effectively handle bursty traffic flows. Active Queue Management (AQM) methods drop packets randomly, even before the queue is full; thereby alleviating the problems due to Drop Tail. Hence, these techniques play an important role in controlling congestion in TCP networks. TCP protocol that are commonly utilized in nowadays network: Droptail and RED. Droptail is easy to implement but has theproblems of lockout and synchronization; RED is complicated but it avoids congestion in advance and reduces the average queue size. Most researches concentrate on the performance of the two algorithms in wired network. But in this dissertation, we discuss the performance of Droptail, RED and REM in wireless network.

Key Words: **Droptail, NS-2, Queue Management, RED, REM.**

1. Introduction

Wireless network is quite different from wired network. The nodes have no wired links to other nodes and base stations, so any barrier that is between the sender and the receiver could influence the transmission power and bring packet loss. Those packet losses are called external sources of losses. The data suffers large-scale fading, which is brought by buildings and large shadows; small-scale fading, which is influenced by multipath; and collision, which happens when several packets arrive to a bottleneck at the same time. All the three aspects cause packet loss. To compare the performance of the three algorithms, simulation models should be established. To resolve the problem, many congestion control algorithms are proposed. Many of the algorithms are based on the evaluation of the feedback from the congested network. Some algorithms detect congestion from warn packets sent back to the source while in other sources observe change in few network parameter like delay, packet drop and detect congestion. In queue management algorithms there are two different types of algorithms, active and passive like DropTail, RED and REM. Drop Tail is the most widely used queue management method in today's IP networks. RED is mostly the default method implemented in the routers nowadays. RED monitors the average queue size and drops packets based on statistical probabilities. REM is an active queue management scheme that aims to achieve both high utilization and negligible loss and delay in a simple and scalable manner. We have analyzed performance of different queue management algorithms by applying them on simulation scenario at different data rates and queue sizes.

In this paper, we will compare popular Queuing Management Techniques, Random Early Detection(RED), DropTail and Random Exponential Marking(REM) in different aspects , such as end-to-end delay, throughput and Packet Drop Rate.

In section II, we have given overview of Queue management techniques. Section III describes implementation, simulation model and topology. Section IV gives performance comparisons with

various queue management techniques by simulation in ns2. Conclusion is presented in section VI.

2. Queue Management Techniques

Queue management is defined as the algorithm that manages the length of packet queues by dropping packets when necessary or required to be dropped. From the point of dropping packets, queue management can be classified into three categories as in the figure.

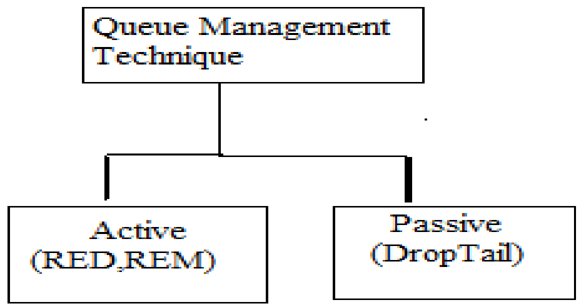

Fig 1: Queue Managment Techniques

2.1 Passive Queue Management

In Passive Queue management (PQM) technique, an Internet router typically maintains a set of queues, one per interface, that hold packets scheduled to go out on that interface. Such queues use a drop-tail discipline: a packet is put onto the queue if the queue is shorter than its maximum size (measured in packets or in bytes), and dropped otherwise.PQM does not employ preventive packet drop before the router buffer gets full.

Droptail:

In Droptail, the router accepts and forwards all the packets that arrive as long as its buffer space is available for the incoming packets. If a packet arrives and the queue is full, the incoming packet will be dropped. The sender eventually detects the packet lost and shrinks its sending window. Drop-tail queues have a tendency to penalize bursty flows, and to cause global synchronization between flows.

2.2 Active Queue Management

Active queue management is expected to eliminate global synchronization and improves quality of service. The expected advantages of active queue management increases the throughput, reduces delay, and avoides lock-out. Random Early Detection (RED), an active queue management scheme, has been recommended by the Internet Engineering Task Force (IETF) as a default active queue management scheme for next generation networks.

In Internet routers, active queue management (AQM) is a technique that consists in dropping or ECN-marking packets before a router's queue is full. Typically, they operate by maintaining one or more drop/mark probabilities, and probabilistically dropping or marking packets even when the queue is short.

RED:

RED is a type of active queue management technique used for congestion avoidance. RED monitors the average queue size and drops (or marks when used in conjunction with ECN) packets based on statistical probabilities. If the buffer is almost empty, all incoming packets are accepted. As the queue grows, the probability for dropping an incoming packet grows too. When the buffer is full, the probability has reached 1 and all incoming packets are dropped. RED is more fair than tail drop, in the sense that it does not possess a bias against bursty traffic that uses only a small portion of the bandwidth. The more a host transmits, the more likely it is that its packets are dropped. The probability of a host's packet being dropped is proportional to the amount of data it has in a queue. Early detection helps avoid TCP global synchronization.

REM:

REM is an active queue management scheme that measures congestion not by performance measure such as loss or delay, but by quantity. REM can achieve high utilization, small queue length, and low buffer overflow probability. Many works have used control theory to provide the stable condition of REM without considering the feedback delay. In case of (Random Exponential Marking) REM, the key idea is to decouple congestion measure from performance measure (loss, queue length or delay). In REM, the user rates are matched by clearing buffers irrespective of number of users. The sum of link prices, summed over all the routers in the path of the user to the end-to-end marking.

3. Simulation Model And Environment

The experiments were conducting using the ns-2 network simulator. There are six nodes in the experiment conducted. One node is acting as a TCP sink node and another as source node. We have simulated the scenario on network on ns2 for different algorithms like Droptail, RED and REM.

We have simulated these algorithms using the figure. We have simulated the scenario by varying the data rate from 5 to 20 Mbps. and by varying queue size from 10 to 25.

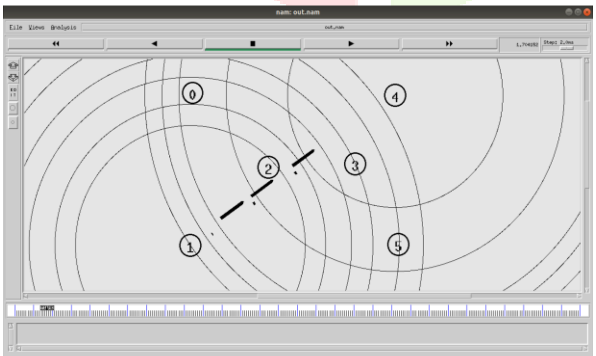

Fig: Simulation Topology

3.1 Simulation Metrics

We have simulated three algorithms of the Passive and Active queue management algorithms like Droptail, RED and REM. Firstly, we have varied the data rate and observed the results. Then, the simulation is done by varying the queue size and observed the Packet loss rate, throughput and End-to-end delay. The simulation metrics are explained below.

3.2.1 Data Rate

The data rate is the amount of data that is moved from one place to another in a given time. In network, the data rate can be viewed as the speed of travel of a given amount of data from node to another. In general, the greater the bandwidth of a given path, the higher the data transfer rate.

3.2.2 Packet Delivery Ratio

It is the ratio of the number of data packets received by the destination node to the number of data packets sent by the source mobile node or Packet Delivery Ratio (PDR) is the ratio between the number of packets transmitted by a traffic source and the number of packets received by a traffic sink. It measures the loss rate as seen by transport protocols and as such, it characterizes both the correctness and efficiency of queue management schemes.

3.2.3 End-to-end Delay

The End-to-end delay is measured as the time elapsed while a packet travels from one point e.g., source node to destination node. The larger the value of delay, the more difficult it is for transport layer protocols to maintain high bandwidths. We have calculated end-to-end delay by of the queue management algorithms and compared the results.

4. Simulation Results And Analysis

In our simulation, we have compared the most popular queue management algorithms. We have studied the change in the Packet drop rate, throughput and end-to-end delay with varying data rate and queue size. Also, observed and analyzed a better algorithm in terms of the above mentioned metrics.

4.1 Data Rate vs. Average Delay:

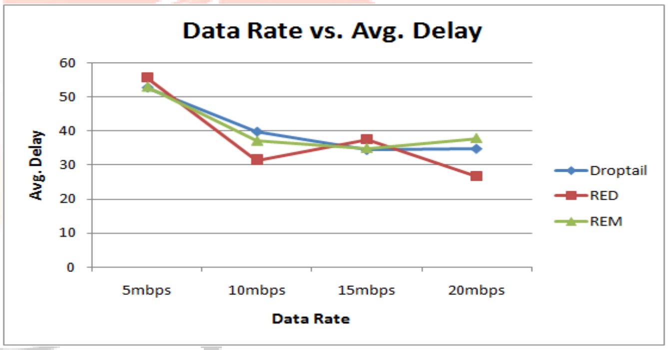

Fig 4.1: Data Rate vs. Average Delay

Average end to end delay comparison graph shown in fig.4.1. Average end to end delay of REM is maximum, RED is minimum and Droptail is between the REM and REM for '5mbps, 10mbps, 15mbps and 20 mbps' scenario.RED is preferable.

4.2 Data Rate vs. Packet Delivery Ratio (PDR):

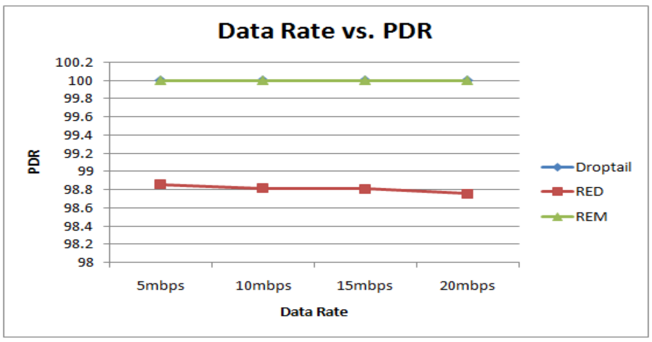

Fig 4.2: Data Rate vs. Packet Delivery Ratio

According to simulation results the Packet delivery ratio of Droptail and REM is maximum, RED is minimum for '5mbps, 10mbps, 15mbps and 20mbps' scenario.Droptail and REM are preferable.

4.3 Data Rate vs. Throughput:

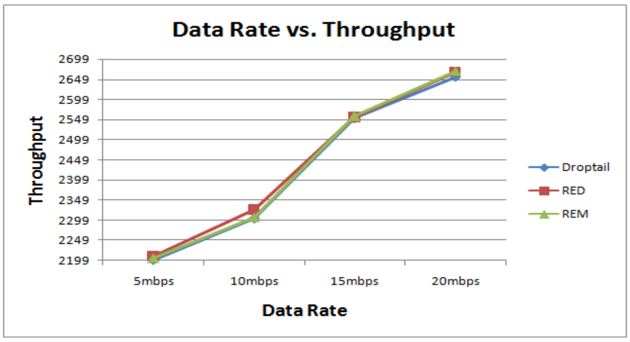

Fig 4.3: Data Rate vs. Throughput

Fig.4.3 shows that, the throughput of RED is better than REM and REM is better than Droptail for '5mbps, 10mbps, 15mbps and 20 mbps' scenario.RED is preferable.

4.4 Queue Size vs. Average Delay:

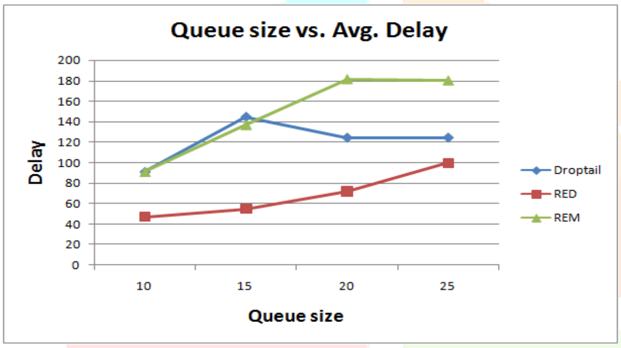

Fig 4.4: Queue size vs. Average Delay

Average end to end delay comparison graph shown in fig.4.4. Average end to end delay of REM is maximum, RED is minimum and Droptail is between the REM and REM for '10 nodes, 15 nodes, 20 nodes and 25 nodes' scenario.RED is preferable.

4.5 Queue Size vs. Packet Delivery Ratio (PDR):

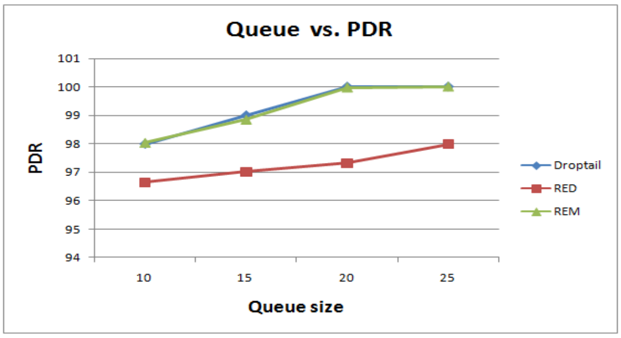

Fig 4.5: Queue size vs. Packet Delivery Ratio

According to simulation results the Packet delivery ratio of Droptail is maximum, REM is slightly less and RED is minimum for '10 nodes, 15 nodes, 20 nodes and 25 nodes' scenario.Droptail is preferable.

4.6 Queue Size vs. Throughput:

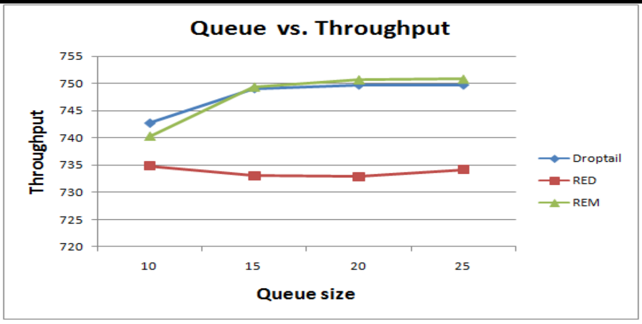

Fig 4.6: Queue size vs. Throughput

Fig.4.6 shows that the throughput of REM is maximum, Droptail is slightly less and RED is minimum '10 nodes, 15 nodes, 20 nodes and 25 nodes' scenario.REM is preferable.

5. Conclusion

In this paper, the performance evaluation of Droptail, RED and REM queue management schemes is done through the simulation tool NS2 which gives the knowledge how to use queue management in dynamic network. Simulation results show the varying performances of the queue management schemes as the number of nodes and data rate varies in the network. In the above simulation results:

- *REM has maximum throughput.*
- *Droptail has minimum packet drop.*
- *RED has minimum average end to end delay.*
- *Droptail provides highest packet delivery ratio.*
- *Droptail is preferred for low configuration networks.*

In the analyzed scenario, it is found that, no single queue management is better in all the cases. We should select the queue management scheme based on our needs and network configuration and topology.

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