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Analyzing Superiority of Tail Drop over Random Early Discard by evaluating throughput using varying queue length in 802.11

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Abstract— Wireless network is used because of cost effectiveness in network deployment, and its applicability to environment where wiring is not possible wireless is preferable solution compared to wired networks. Congestion is a problem that happens due to surpass in an aggregate demand as compare to the accessible ability of the resources. It has a greater impact on both the wired and wireless network. Ns-2 is used in simulating system models, the loss in the channel can be easily distinguished from the trace file. Even though RED sometimes has better performance than Tail Drop and vice versa, we cannot say that RED has the dominance, because the total number of nodes in a real wireless network changes every moment. The average queue or buffer size of the RED is smaller than the average queue length of Tail drop.

Keywords— Queue management, queue length, throughput, RED, Tail Drop etc

1. Introduction

Queue management is a way to control the queue length, when congestion arises in the network. It contains passive queue management and active queue management. Tail Drop and Random Early Discard (RED) is algorithms that represent these techniques respectively. In passive queue management packets are dropped when buffer is full where as in active queue management packet drops when buffer is getting full. It overcomes the “lock out” and “global synchronization” problem of passive queue [8].Many researches of the two algorithms are in wired network. And most of the real wired network uses Random Early Discard. However, nowadays wireless network become more well-liked in people’s lives, so we want to analyze the performance of active queue management and passive queue management algorithm in 802.11 networks.

Wireless network is used because of cost effectiveness in network deployment, and its applicability to environment where wiring is not possible or it is preferable solution compared with wired networks. Congestion is a problem that happens due to exceed in an increase in demand compared to the available capacity of the resources. It has a greater impact on both the wired and wireless network and causes the problems of lockout and packet loss. Therefore, several congestion control method are proposed to solve this problem and elude the damage. To sense and analyze congestion several feedback method are used in the network. However, there are generally two categories namely: implicit feedback and explicit feedback. For detecting the congestion inside the network, researchers and the IETF proposed a mechanism called active queue management (AQM). To preserve and increase WAN performance, they intensely suggested the deployment of AQM in the routers. In order to avoid a haphazard behavior when a link experiences congestion, several different queue management schemes has been proposed, such as Random Early Drop (RED), Flow Random Early Drop (FRED), BLUE, Stochastic Fair BLUE (SFB) and CHOKe (CHOose and Keep for responsive flows, CHOose and Kill for unresponsive flows) [1].

2. Queue Management

Queue management is used to control queues and as well as provide service expectation also. In networking, it is needed when several flows coming at a single link it becomes a bottleneck. Consider the network whose topology shown in figure3.1. The bandwidth between sources and router 1 to 15 Mb, but the bandwidth between routers is 4 Mb. So the link amid two routers is the bottleneck link. When packets from Senders arrive to Router, they buffered and wait for transmission. However, the buffer size is limited. Congestion occurs, when the source is kept transmitting and the buffer is full. It will cause lockout and congestion collapse, and it will take a long time to restore the network [4]. To control congestion queue management is used. It controls the queue length when the buffer reached to its threshold point. Besides that, in wireless networks, TCP congestion control and CSMA/CA with exponential back-off is used

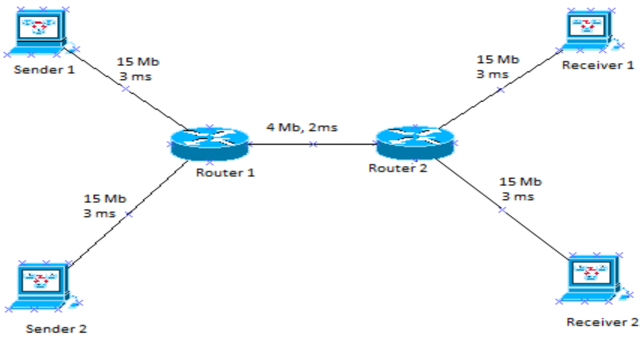

Figure 1 Basic network topology

2.1 TAIL DROP

"Tail Drop" or "drop tail" is one of the common passive queue management algorithms. It simply drops all the incoming packets when the buffer becomes full, and does not take any action if the buffer still has space. The packet dropping probability is 1, when the number of packets arrived in the queue are larger than buffer space. Otherwise the probability of dropping packets is 0. The algorithm does not have any complicated parameters and its implementation is easier. But it also suffers from various shortcomings such as lockouts and global synchronization. In lockout situation, except one or few connections all the others decrease their transmission rate, due to this the buffer is full of packets of connections with high rates. Synchronization is when all the connections increase or decrease their transmission rates together.

2.2 RED (Random Early Drop)

The well-known active queue management algorithm is RED; it is only developed for TCP. When the average queue size is larger than minimum threshold it starts dropping packets, and when the average queue size is larger than the maximum threshold the dropping probability changes to 1. When the average queue length is between the minimum thresholds (T_{min}) and maximum thresholds (T_{max}) the dropping probability is varies from 0 to p [2].

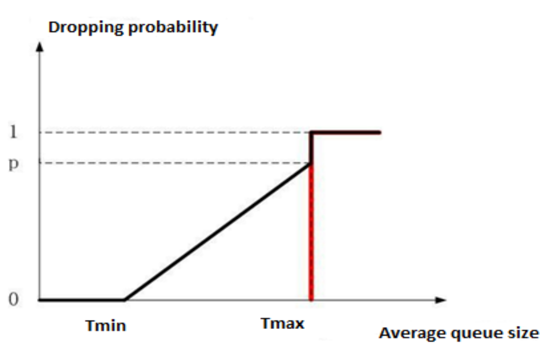

Figure.2 Comparison of dropping probability of RED and Tail Drop

The figure.2 presents the dropping probability of RED and Tail Drop in red line: The thing that makes a difference between RED and Drop tail is that RED uses average queue length instead of instant queue length and low pass filter is used to calculate the average queue length. The setting of maximum threshold and minimum threshold should be considered in the different network. If minimum threshold is high it leads to high link utilization, while small minimum threshold results in small delay. Usually, maximum threshold is twice greater than minimum threshold. RED is a complicated algorithm and its performance is depend on the parameters we choose. But it avoids the congestion before the queue getting full and resolves the problem of synchronization and lockout.

3. SIMULATION SETUP

Performance of wireless network mainly depends on the end to end throughput and delay. Requirements of different applications are different on the network. Ns-2 is used in simulating models [7] [11]. Using this simulator, the topologies of the models are clearly presented and the processes of packet transmitting and packet dropping are reflected by analyzing the trace files and monitoring the TCP sinks, we can easily get the information of the network in details, such as 'a packet is sent at 0.1 seconds'. With the help of these details we analyze the performance of RED and Tail drop in wireless network. We need to test the throughput and average queue size of the two algorithms with external source of losses, to analyze the superiority of Tail drop over RED in wireless 802.11. So the first model is an abstract model is used to simulate packet losses of wireless network in a wired network. And in second, we simulate the 802.11 model. In this model, collisions happens when packets from senders arrive to base station even CSMA/CA with backoff algorithm is used.

3.1 ABSTRACT MODEL- The abstract model is used to simulate the packet loss of wireless network in a wired network. The purpose of the model is to find the relationship between throughput and probability of packet loss [10]. Error model is added to the model to simulate the external source of losses [11]. The rate of loss can be set from 0 to 1. The topology of the abstract model is displayed in Figure 3. The network comprises of senders, receivers and two routers. The number of senders or receivers can be set to 2, 5, 10, 20 or 40. Each sender transmits messages to the receiver which has the same number to it through the two routers. The bandwidth of the link between router and node is 15 Mbps, and the delay is 4ms. The link between two routers has a bandwidth of 2.5 Mbps and a delay set to 20 ms. It is clear that the link between routers is bottleneck link of the network. The packets sent from the sources queue in the buffer of Router 1 and wait for transmitting.

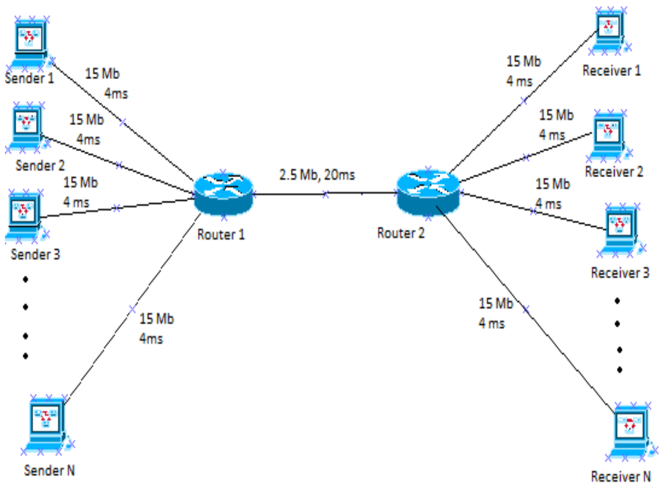

Figure 3 Topology of the abstract model

If the queue becomes full and the senders keep transmitting, congestion will happen. To manage the queue and control congestion, the two algorithms, RED and Tail drop are used.

The loss in the channel can be easily distinguished from the trace file, while there are losses in both the buffer and the channel. The following data is the external loss information in trace file [7] [11] : two types of losses due to buffer or channel.

\- 0. 316432 0 10 tcp 1500 ----------0 0.0 5.0 18 95

d 0. 316755 10 11tcp 1500 ----------1 1.0 6.0 8 46

the packet dropped is not just after the packet is received by the router.

\+ 0. 062648 40 41 tcp 1500 --------22 22.0 62.0 2 25

d 0. 062648 40 41 tcp 1500 --------22 22.0 62.0 2 25

The packet is drops immediately after it has been received by the router. This shows the difference between two types of losses. Even though packet delay is a reason of slow start and retransmitting we do not consider that in our system, because compared to packet loss, packet delay is very small

Throughput- In the simulation, we compute the average throughput between Sender and Receiver and write it in a trace file. The interval of each sample is 0.3 s. the layout of the tracefile is below:

60.400000000000319 0. 27278675496688598

60.600000000000322 0. 2742627062706256

60.800000000000325 0. 27355789473684067

The first column is the simulation time and the second column is the average throughput from the beginning to that instant.

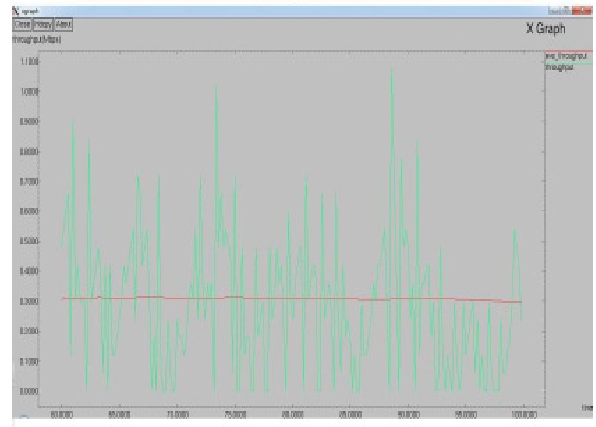

Figure. 4 Throughput of Tail drop in x-graph

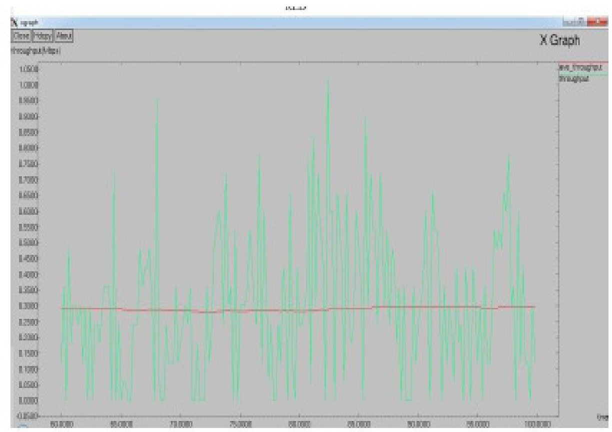

Figure. 5 Throughput of RED in x-graph

The average queue size of the buffer is obtained by an awk code which is used to analyze the trace file line by line. The information in a trace file is as following:

\+ 0. 02028803 tcp 1500 ------- 1 0. 0 5. 0 24

\- 0.02028803 tcp 1500-------1 0. 05. 0 24

3.2 Wireless Model

The wireless model simulates the WIFI network. There is no peripheral cabling between nodes and base stations i.e. all the nodes are wireless, so any hindrance between sender and receiver could influence the transmission power and causes packet loss. Packet loss due to these reasons is called external sources of losses. The topology in this model is similar to the topology in wired network, but the NS2 codes are different. It is necessary to set the parameters of the wireless network accordingly such as MAC layer type and Physical layer type [3]. The base station can only able to control the nodes in the

range of reception distance; the receivers and base station belong to one domain.
The trace file of wireless network is different from the trace file of wired network [5] [7] [9]:

s 90. 327930807 _10_ AGT ---- 4837 tcp 1500[0 0 0 0]-----[9:0 4194314: 0 32 0] [201 0] 0 0

r 90. 327930807 _10_ RTR ---- 4837 tcp 1500[0 0 0 0]-----[9:0 4194314: 0 32 0] [201 0] 0 0

3. Result

We got the subsequent graph about the throughput and average queue size of RED and Tail Drop. While packet delay is a cause of packet loss, we do not consider in our simulations, because the number of packets lost by packet delay is quite diminutive, compare to the number of packets dropped due to queue management. In figures below, the average queue size is the average queue length of the buffer in Router1.
The probability of packet loss here refers to the external sources of losses that are bought by the error model, not by Tail Drop or RED. From these figures, we know that the average queue length of Tail Drop is larger than RED. The reason is that the probability of packet loss is massive and the amount of nodes is limited. So both Tail drop and RED have very low link utilization. These are the result of first abstract model:

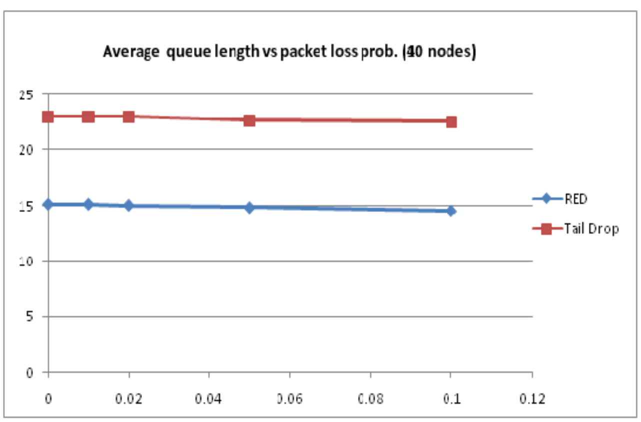

Figure.6 Average queue length vs. probability of packet loss

Figure.6 shows the average queue size vs. packet loss probability with 25 buffer size. , it is obvious that the average queue of Tail drop is larger than RED in most of the cases. When the amount of nodes is small, the average queue length of RED and Tail drop are approximate in high packet loss probability. However, as the amount of nodes grows up, the average queue size of Tail drop increases faster than that of RED. The reason is that RED controls the queue length actively. The throughput is obtained by tracing the link between the first sender and its receiver; it can be analyzed with the trace files.

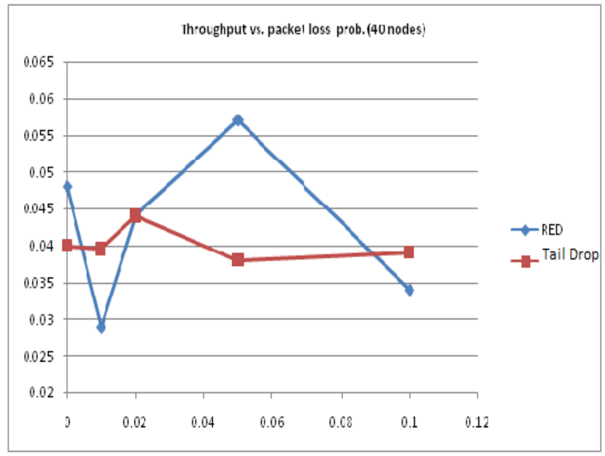

Figure.7 Throughput vs. probability of packet loss

The figure.7 above shows the throughput and packet loss probability with 50 packets queue length. In these figures it has been seen that there is no superiority of RED. We know that if a packet loss probability is changes, there is no dominance between RED and Tail drop. The differences between RED and Tail drop in throughput are not huge, even the maximum buffer size taken to 50 packets.
Although RED gets less queue size than Tail drop, the throughputs of the two algorithms are approximately equal. Even though RED sometimes has better performance than Tail Drop and vice versa, we cannot say that RED has the dominance, because the total number of nodes in a real wireless network changes every moment. Compared to Tail Drop, RED is more complex. So it is not essential to use RED in wireless network.
The figure below, are the statistical observation of the simulation result of the second wireless model.

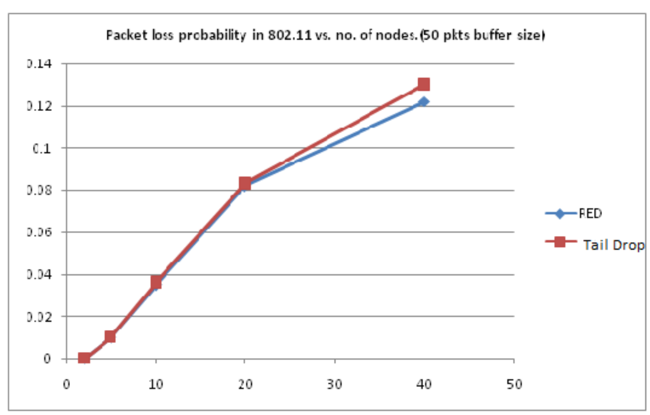

Figure.8 Probability of packet loss vs. no of nodes

Figure8. Probability of packet loss and number of nodes As shown in two figures, the packet loss probability of RED and tail drop are approximate with a certain amount of nodes. From the abstract model, we came to know that the throughputs of RED and tail drop under the same packet loss probability are approximate. After that, merge the two models, we can get the relationship between queue length and amount of nodes, and throughput and amount of modes.

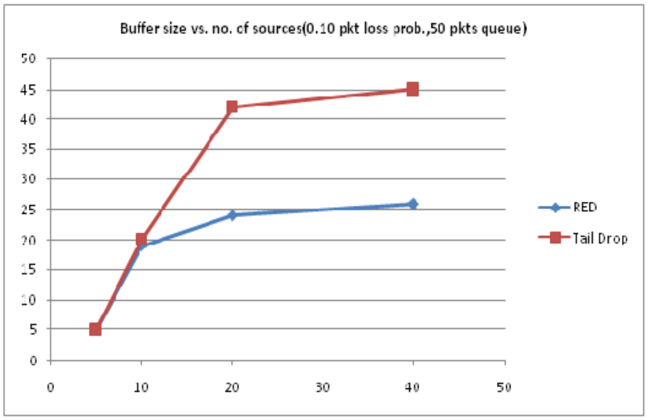

Figure.9 Buffer size vs. no of nodes

The average queue or buffer size of the RED is smaller than the average queue length of Tail drop. That means the delay of RED is shorter than the delay of Tail drop

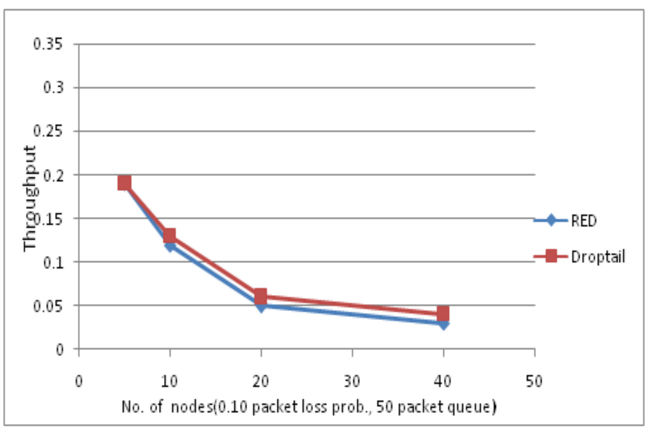

Figure.10 Throughput vs. no of nodes

We analyze that RED does not show the superiority in most of the cases. The result is definitely same to the results of previous figure. Due to this result, and the fact that RED is complex than Tail Drop, So with this analysis we concluded that RED is not recommend in the wireless network, although it has a shorter packet delay than Tail Drop.

Conclusion

We presented a simulation-based performance evaluation and comparison of Tail drop and RED queuing techniques with different number of nodes, size of packet and throughput. The throughput of RED depends on the mode of parameters and the intensity of traffic and in RED if queue length is increases packet loss probability also increases. Small queue size represents short delay, so if RED gets the same throughput to Tail drop, it is still recommended but it is obtained that the throughput of RED has no superiority compared to Tail drop when some external source of losses is added.

In the ***802.11 model***, it is observed that the packet loss probabilities of RED and Tail Drop for a certain amount of nodes they are approximately equal. But in wireless the scenario is not fixed it changes abruptly. Although RED are also very close to Tail drop for the considered node scenarios, it monitors the average queue size and, if congestion is detected randomly drops packets. But Tail drop is more superior than RED in wireless network.

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