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Analysis of Network Performance in Heterogeneous Network over Different AQMS

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Abstract: A MANET is a single network including Internet, may be connected to a larger network. All nodes free of every other node can communicate with each other and in this type of network nodes are independent. An example of a P2P network and multi - hop network are connected. The heterogeneous nature of the networks can sometimes create problem in the traffic management on the backbone links. The multimedia traffic and graphics mostly flows on UDP and traffic like HTTPS and link management's flows on TCP. In order to analyze the traffic management, we must understand the behavior of various Active Queue Management Techniques on different traffic classes via TCP and UDP. In this thesis, a multi class network is analyzed for both TCP and UDP traffic classes for various network performance parameters like Throughput, Packet loss ratio and Average end to end delay for various networks Active Queue Management Techniques. In the thesis four Active Management Techniques are tested for both TCP and UDP traffic classes. Most of the fast multimedia and graphics traffic is based on UDP. Therefore analysis of this type of traffic class of supremely important. In this paper, a concise result analysis of detail findings is represented of Drop Tail, SFQ, RED, and REM under varying network conditions. The throughput of the network in calculated by varying the network conditions like bandwidth, delay, channel error rate. In case of TCP it has been observed SFQ was intended to perform best in as it employs Fair Queuing Algorithms for the handling of flow of packets on link with simultaneous sessions. On the other hand in UDP Drop tail, RED and REM performed best in different scenarios as their Queue management involves only the link state and the congestion and not on the traffic flow.

Keywords: RED, REM, SFQ, Drop Tail, MANET, Throughput, Packet Loss Ratio.

I. INTRODUCTION

A. Mobile Ad-hoc Network

Mobile ad-hoc network is a framework of dynamic network existing of a set of a wireless mobile node they are communication with another without using of any integrate rule. A wireless medium, dynamic topology, distributed as support for its basic characteristics, MANETs worm holes, etc. Different types of attacks, such as the security black hole, escaping attacks is weak. Manet is a standalone network and it can be connected to internet networks(external).Manet Is a set of applications for lead to different, big , mobile, highly dynamic network small, fixed networks are limited to Energy resources . Ad hoc networking is a device allows maintaining connections to the network as well as easily adding and removing the devices to the network. Aarti and Dr. S.S. Tyagi [1]

Fig 1: Example of mobile ad-hoc network

B. Active Queue Management

Internet routers , active queue management (AQM) or specific explicit congestion notification (ECN) of a router queue is full , are included in the packet marking , is a technique that, An Internet router interface that is normally scheduled to go out at packet queue interface that contains a set of one per . Row (in bytes packet or measured) is less than the maximum size of a packet queue has been put on, and fall: Historically, a drop in a row - use tail discipline. Chung and Claypool [2], Ke, et al. [3].

C. Active Queue Management Techniques

The network is more complex in nature and complex to be included, but in limited network resources are always there. Bandwidths due to high prices, in the performance of network resources, are always limited him. Ram and Manoj [4]. There are few AQM Techniques used in MANETs which are as under

- Drop Tail
- RED (Random Early Detection)
- REM (Random Exponential Marking)
- SFQ (Stochastic Fair Queuing)

We are more popular in detail and general AQM technique SFQ, RED, REM, and Drop Tail are going to discuss.

1. Drop Tail

When a simple queue mechanism that is used by routers to drop rooms come to accept traffic, while in this mode, each packet, and packet display rows are decreasing, filled to its maximum capacity until new rows have been treated for Drop Tail's weakness has filled a row, when the router leaving the tail of this procedure to cancel the extra packet that is to begin.Kamalpreet, Navdeep, Gurjeevan[5].

2. Random Early Detection

Random Early Detection (RED) Lynn and Morris [6], particularly in high-speed transportation network, which is useful as possible (as opposed to a crowd administration) procedure appear, avert a crowd. Sally Floyd and Van Jacobson in the early 1990s in various papers presented it. If the buffer is empty, all incoming packets are accepted. As the size of the queue, a packet also enhances the possibility to cancel the increase.

3. Random Exponential Marking

Random exponential Marking (REM) is a great adaptive queue management algorithm. The crowd in a network to measure the amount known as the price uses. REM high scalability, small queue length, and less potential buffer overflow can get. Many works without considering a delay of REM stable condition control theory is used to provide. Kwon and Fahmy [7], Victor et al. [8].

4. Stochastic Fair Queuing

Fair queuing relatively link capability to share multiple packet flow that has been used to implement a queuing mechanism. SFQ also ensure maximum throughput of the network. For each communication it is impractical to have a row, because the queuing mechanism is based on fair queuing algorithm is proposed in 1987 by John Nagle SFQ than a limited number of rows that distributes traffic hashing algorithm uses. Paul E. Mc Kenney [9].

In this paper we present a relatively heterogeneous network with both UDP and TCP traffic flowing in the network. If we study the performance of UDP traffic class and TCP traffic class in a network, it becomes easier to predict the behavior of multimedia traffic class as it will be sent over the UDP in the simulations.

The remainder of this paper is organized as follows. In Section II we present the performance metrics of our simulation. Section III provides the Simulation Environment. Section IV shows the results analysis by showing the different graphs considering different parameters. Section V presents the concluding remarks and future scope.

II. PERFORMANCE EVALUATION METRICS

We analyse the UDP traffic and TCP traffic on the main router to router link by considering the Throughput and Packet loss parameters

Throughput: Throughput or network throughput is number of bits delivered successfully per second to the destination. It is the sum of bits received successfully by all destinations. This data may be delivered over a physical or logical link. The throughput is measured in bits per second (bps) [11]. Mathematically, it can be defined as:

$$\textbf{Throughput} = N/1000$$

Where N is the number of bits which is received successfully by all destinations.

Total Packet loss: Packet loss is the failure of one or more transmitted packets to arrive at their destination. In digital communication, Packet loss is distinguished as one of the three main error types, the other two being bit error and spurious packets caused due to noise A problem of packet loss is much more complicated in Mobile Ad hoc Networks because wireless links are subject to transmission errors and the network topology changes dynamically. In our experiments we calculate the

$$\text{Packet loss rate} = \frac{\text{No. of packets sending} - \text{No. of packets received}}{\text{No. of packets sending}} * 100$$

III. SIMULATION ENVIRONMENT AND NETWORK PARAMETERS

The topology of the network created

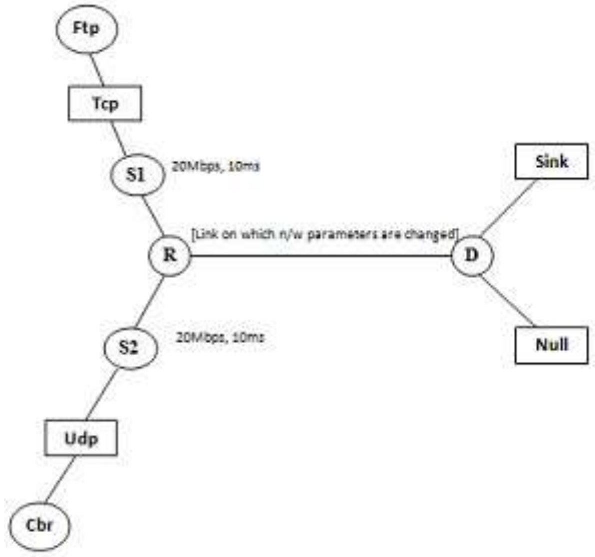

Fig 2: Simulation Scenario

The network has 2 source nodes (S1 & S2), one generating TCP traffic which is attached to FTP agent and the other generating UDP traffic to CBR (Constant Bit Rate) be transferred at the destination node and two routers are set in between source nodes and destination node. All the two parameters bandwidth, delay, fragment size are varied on the link between R & D by keeping delay constant at show in fig 3. The destination node (D) is connected to two receiving nodes in which sink agent that is the receiver side attached to record the information for UDP based application at the receiver side attached to D.

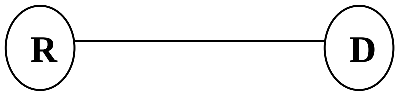

Fig 3: The network parameters are changed on the link (R-D)

The parameters are changed in the network. In first case, the bandwidth of the main router to router link [R-D] is changed keeping the other network parameters unchanged. In the second case, the delay of the main router to router link [R-D] is changed keeping the other network parameters unchanged. In the third case, the channel error rate of the main link is changed and in the fourth case the packet size is changed.

IV. RESULTS ANALYSIS

We have analyzed the results for two different performance evaluation- Throughput, Packet Loss Rate perform in three parameters bandwidth, delay, channel error rate. Here simulation results are represented in the form of graphs as follows.

1. UDP Traffic Analysis

A. Throughput vs. AQM

In this we are analyzing the throughput in the different Graphs by varying the network parameters and AQM techniques:

Effect of varying Bandwidths: for 10 ms delay and channel error rate 0.

Fig. 4: Shows the effect of fragment size 256, 512, 1024 KB on THROUGHPUT. We have kept the delay and the channel error rate constant and performance evaluation of AQM at varying different bandwidths.

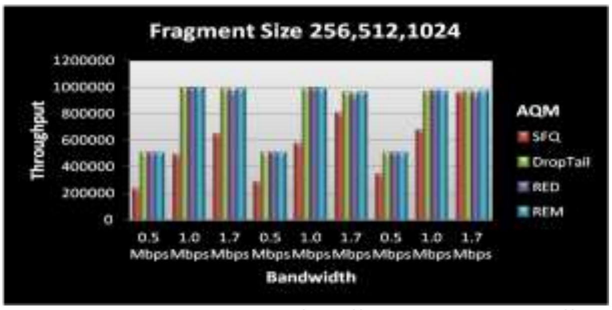

Fig 4: Throughput vs. AQM for different bandwidth at different fragment sizes

Fig 4: Show the impact on THROUGHPUT for different fragment sizes by varying Bandwidth keeping delay and channel error rate to be constant. At delay 10 ms and channel error rate 0 throughput increases as bandwidth increases for constant fragment sizes. SFQ has worst throughput for all bandwidths. RED, REM, Drop Tail have best throughput for all bandwidths.

Effect of varying Delay: for 1.7 Mbps bandwidth and channel error rate 0.

Fig. 5: Shows the effect of fragment size 256, 512, 1024 KB on THROUGHPUT. We have kept the bandwidth and the channel error rate constant and performance evaluation of AQM at varying different delays.

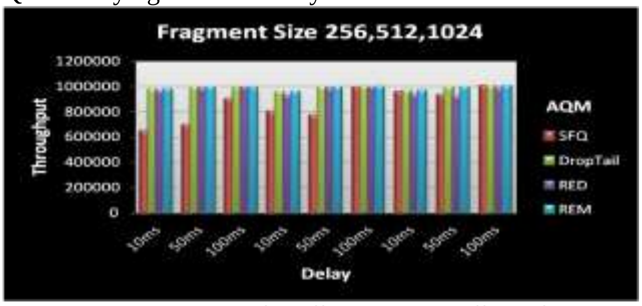

Fig 5: Throughput vs. AQM for different delay at different fragment sizes

Fig 5: Show the impact on THROUGHPUT for different fragment sizes by varying Delay keeping bandwidth and channel error rate to be constant. At bandwidth 1.7Mbps and channel error rate 0 throughput increases as delay increases for constant fragment sizes. The Throughput increases as the fragment size increases for constant Bandwidth.SFQ has worst throughput for all delays. RED, REM, Drop Tail have best throughput for all delay.

Effect of varying Channel Error Rate: for 1.7 Mbps bandwidth and 10 ms delay.

Fig. 6: Shows the effect of fragment size 256, 512, 1024 KB on THROUGHPUT. We have kept the bandwidth and delay constant and performance evaluation of AQM at varying different channel error rate

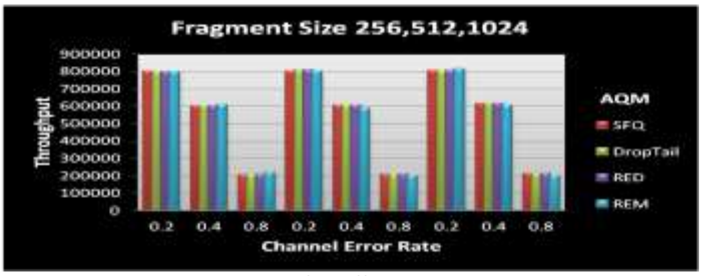

Fig 6: Throughput vs. AQM for different Channel error rate at different fragment sizes

Fig 6: Show the impact on THROUGHPUT for different fragment sizes by varying Channel Error Rate keeping bandwidth and delay to be constant. At bandwidth 1.7Mbps and delay 10 ms throughput decreases as Channel Error rate increases. All AQM schemes are independent of Fragment Size in terms of throughput.

B. Packet Loss Rate vs. AQM

In this we are analyzing the Packet Loss Rate in the different graphs by varying the network parameters and AQM techniques:

Effect of varying Bandwidths: for 10 ms delay and channel error rate 0.

Fig. 7: Shows the effect of fragment size 256, 512, 1024 KB on PACKET LOSS RATE. We have kept the delay and the channel error rate constant and performance evaluation of AQM at varying different bandwidths.

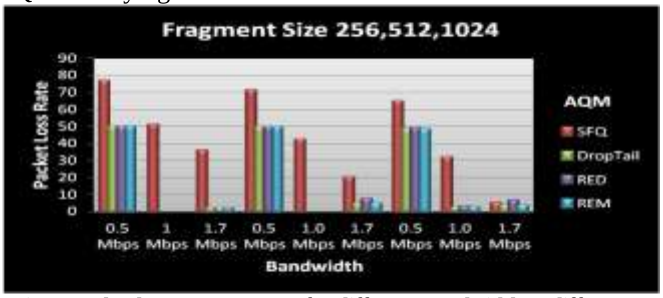

Fig 7: Packet loss rate vs. AQM for different Bandwidth at different Fragment Sizes

Fig 7: Show the impact on PACKET LOSS RATE for different fragment sizes by varying Bandwidth keeping delay and channel error rate to be constant. At delay 10 ms and channel error rate 0 Packet loss rate decreases as bandwidth increases for constant fragment sizes. Packet loss rate decreases as the fragment sizes increases for constant bandwidth. SFQ has worst packet loss rate for all bandwidths. RED has best packet loss rate for all bandwidths

Effect of varying Delay: for 1.7 Mbps bandwidth and channel error rate 0.

Fig. 8: Shows the effect of fragment size 256, 512, 1024 KB on PACKET LOSS RATE. We have kept the bandwidth and the channel error rate constant and performance evaluation of AQM at varying different delays.

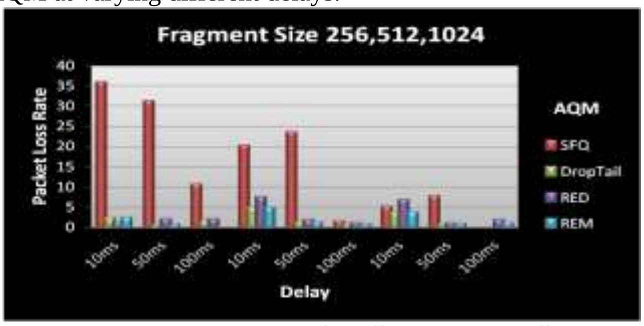

Fig 8: Packet loss rate vs. AQM for different Delay at different Fragment Sizes

Fig 8: Show the impact on PACKET LOSS RATE for different fragment sizes by varying Delay keeping bandwidth and channel error rate to be constant. At bandwidth 1.7Mbps and channel error rate 0 Packet loss rate decreases as delay increases for constant fragment sizes. Packet loss rate decreases as the fragment sizes increases for constant bandwidth. SFQ has worst throughput for all delays. REM and Drop Tail have best throughput for all delay.

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Effect of varying Channel Error Rate: for 1.7 Mbps bandwidth and 10 ms delay.

Fig. 9: Shows the effect of fragment size 256, 512, 1024 KB on PACKET LOSS RATE. We have kept the bandwidth and delay constant and performance evaluation of AQM at varying different channel error rate

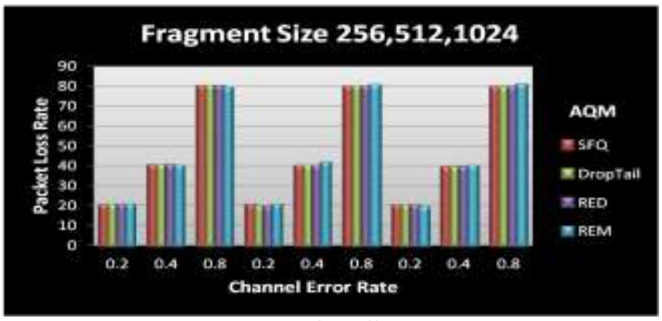

Fig 9: Packet loss rate vs. AQM for different Channel Error Rate at different Fragment Sizes

Fig 9: Show the impact on PACKET LOSS RATE for different fragment sizes by varying Channel Error Rate keeping bandwidth and delay to be constant. At bandwidth 1.7Mbps and delay 10 ms packet loss rate increases as Channel Error rate increases. All AQM schemes are independent of Fragment Size in terms of Packet Loss Rate.

2. TCP Traffic Analysis

A. Throughput vs. AQM

In this we are analyzing the throughput in the different Graphs by varying the network parameters and AQM techniques:

Effect of varying Bandwidths: for 10 ms delay and channel error rate 0.

Fig. 10: Shows the effect of fragment size 1024 KB on THROUGHPUT. We have kept the delay and the channel error rate constant and performance evaluation of AQM at varying different bandwidths.

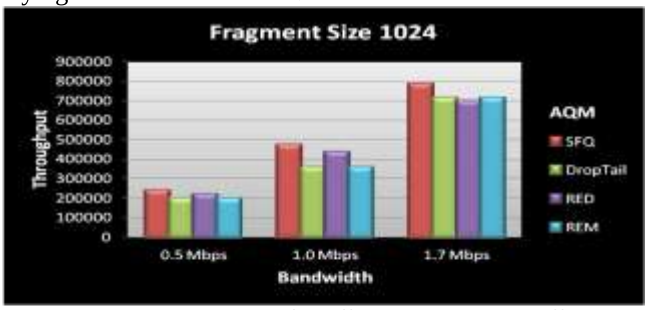

Fig 10: Throughput vs. AQM for different bandwidth at different fragment sizes

Fig 10: Show the impact on THROUGHPUT for different fragment sizes by varying Bandwidth keeping delay and channel error rate to be constant. At delay 10 ms and channel error rate 0 Throughput increases when Bandwidth increases. SFQ has best throughput for all bandwidths. Drop Tail and REM has worst throughput for all bandwidths

Effect of varying Delay: for 1.7 Mbps bandwidth and channel error rate 0.

Fig. 11: Shows the effect of fragment size 1024 KB on THROUGHPUT. We have kept the bandwidth and the channel error rate constant and performance evaluation of AQM at varying different delays.

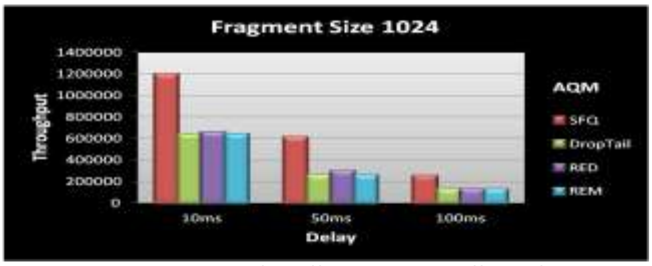

Fig 11: Throughput vs. AQM for different delay at different fragment sizes

Fig 11: Show the impact on THROUGHPUT for different fragment sizes by varying Delay keeping bandwidth and channel error rate to be constant. At bandwidth 1.7Mbps and channel error rate 0 Throughput decreases when the delay increases. SFQ has best throughput for all delays. Drop Tail and REM has worst throughput for all delays.

Effect of varying Channel Error Rate: for 1.7 Mbps bandwidth and 10 ms delay.

Fig. 12: Shows the effect of fragment size 1024 KB on THROUGHPUT. We have kept the bandwidth and delay constant and performance evaluation of AQM at varying different channel error rate

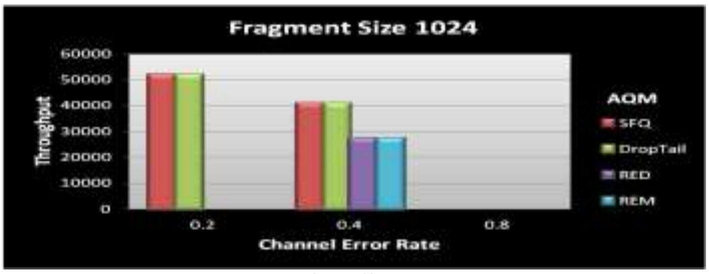

Fig 12: Throughput vs. AQM for different Channel error rate at different fragment sizes

Fig 12: Show the impact on THROUGHPUT for different fragment sizes by varying Channel Error Rate keeping bandwidth and delay to be constant. At bandwidth 1.7Mbps and delay 10 ms Throughput decreases when the channel error rate increases. SFQ and RED have best Throughput at all channel error rates Drop Tail and REM have worst throughput for channel error rates.

B. Packet Loss Rate vs. AQM

In this we are analyzing the Packet Loss Rate in the different graphs by varying the network parameters and AQM techniques:

Effect of varying Bandwidths: for 10 ms delay and channel error rate 0.

Fig. 13: Shows the effect of fragment size 1024 KB on PACKET LOSS RATE. We have kept the delay and the channel error rate constant and performance evaluation of AQM at varying different bandwidths

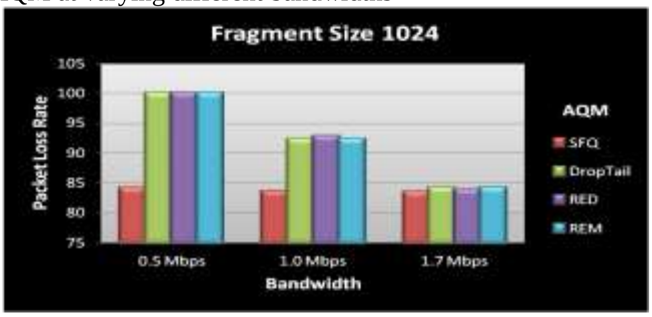

Fig 13: Packet loss rate vs. AQM for different Bandwidth at different Fragment Sizes

Fig 13: Show the impact on PACKET LOSS RATE for different fragment sizes by varying Bandwidth keeping delay and channel error rate to be constant. At delay 10 ms and channel error rate 0 Packet loss rate decreases as the Bandwidth increases. SFQ has least Packet loss rate for all Bandwidths. RED has largest Packet loss rate for all Bandwidths

Effect of varying Delay: for 1.7 Mbps bandwidth and channel error rate 0.

Fig. 14: Shows the effect of fragment size 1024 KB on PACKET LOSS RATE. We have kept the bandwidth and the channel error rate constant and performance evaluation of AQM at varying different delays.

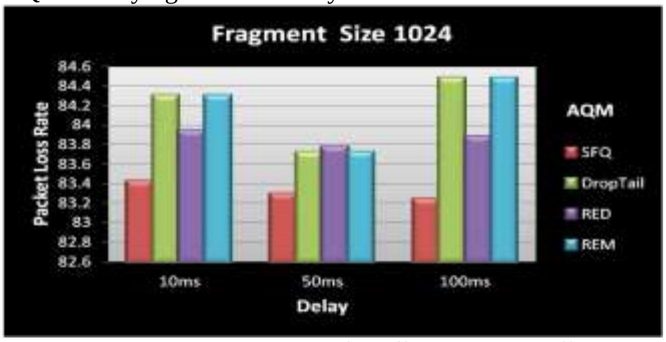

Fig 14: Packet loss rate vs. AQM for different Delay at different Fragment Sizes

Fig 14: Show the impact on PACKET LOSS RATE for different fragment sizes by varying Delay keeping bandwidth and channel error rate to be constant. At bandwidth 1.7Mbps and channel error rate 0 Packet loss rate increases for all AQMs as the delay increases. SFQ has least Packet loss rate for all Delays. RED has largest Packet Loss rate for all Delays.

Effect of varying Channel Error Rate: for 1.7 Mbps bandwidth and 10 ms delay.

Fig. 15: Shows the effect of fragment size 1024 KB on PACKET LOSS RATE. We have kept the bandwidth and delay constant and performance evaluation of AQM at varying different channel error rate

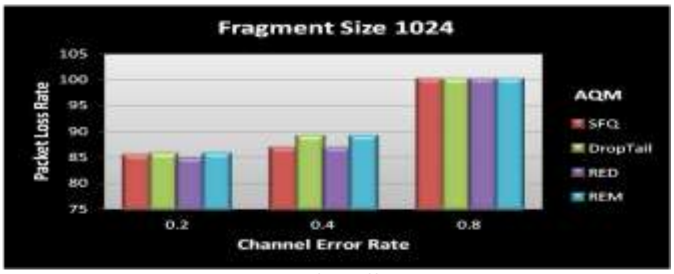

Fig 15: Packet loss rate vs. AQM for different Channel Error Rate at different Fragment Sizes

Fig 15: Show the impact on PACKET LOSS RATE for different fragment sizes by varying Channel Error Rate keeping bandwidth and delay to be constant. At bandwidth 1.7Mbps and delay 10 ms Packet loss rate increases as the channel error rate increases. RED has least Packet loss rate for all channel error rates. REM has highest Packet Loss for all Channel error rates.

The comparative analysis of the Active Queue techniques is shown in Table 16

Table 16- Comparison of active queue management techniques with performance parameters

Parameter	TCP Best	TCP Worst	UDP Best	UDP Worst
Throughput (Varying Bandwidth)	SFQ	DropTail, REM	RED, REM, DropTail	SFQ
Throughput (Varying Delay)	SFQ	DropTail, REM	RED, REM, DropTail	SFQ
Throughput (Varying Channel Error Rate)	SFQ, RED	DropTail, REM	RED, REM, DropTail	SFQ
Packet Loss Rate (Varying Bandwidth)	SFQ	RED	RED	SFQ
Packet Loss Rate (Varying Delay)	SFQ	RED	REM, DropTail	SFQ
Packet Loss Rate (Varying Channel Error Rate)	SFQ	DropTail, REM	RED, REM, DropTail	SFQ
Average End-to-End Delay(Varying Bandwidth)	SFQ	RED	REM, DropTail	SFQ
Average End-to-End Delay(Varying Delay	SFQ	RED	REM, DropTail	SFQ
Average End-to-End Delay(Varying Channel Error Rate)	SFQ	DropTail	RED, REM, DropTail	SFQ

V. CONCLUSION & FUTURE SCOPE

The analysis of Multi-traffic class network reveals that different Active Queue Management schemes respond differently to both traffic classes.

The best choice of AQM technique for connection oriented protocols (for all testing conditions like on various bandwidths, varying delay and varying channel error rate) that is TCP based protocol is SFQ.

- SFQ has best throughput,
- SFQ has least packet loss rate
- SFQ has least average end to end delay
- Drop Tail and REM have worst throughput
- RED has worst packet loss rate.
- RED has worst average end to end delay.

The best choice of AQM technique for connection oriented protocols (for all testing conditions like on various bandwidth, varying delay and varying channel error rate) that is UDP based protocol is

- RED, REM and Drop Tail have best throughput for all testing conditions.
- RED has best packet loss ratio for all bandwidth.
- REM and Drop Tail has best packet loss ratio of all delays.
- RED, REM and DT has best packet loss ratio of all Channel error rates.

- Drop Tail and REM performs best for Average End to end Delay at lower bandwidths (0.5Mbps and 1.0 Mbps)
- RED performs best at for Average End to end Delay higher bandwidth (1.7 Mbps)
- SFQ performs the worst for all parameters for UDP traffic

The thesis focuses of the analysis of traffic in Mobile ad hoc network operating under different Active Queue Management techniques. With the advancements of security requirements and Quality of Service (QOS) requirements in networks, there has been an increase in the development of routing protocols for MANETs.

1. The thesis may provide a platform for the researchers to perform network analysis of newer Routing protocols like TORA, ZRP etc.
2. In this thesis we have analyzed the network performance parameters like throughput, average end to end delay and packet loss ratio. Some other network performance parameters can be analyzed in the future like Signal to Noise Ratio, PSNR, and Peak Delay etc.
3. The network parameters that are analyzed are Bandwidth delay and channel error rate. Different communication channels like Ethernet cables, coaxial cables, serial cables and fiber optical cables react differently to noise, fading, distortion, EMI and synchronization etc. Channel's inherent response to factors causing errors is known as Channel error rate. Fiber optic cables have the least error rate goal whereas traditional serial cables and coaxial cables are more prone to errors. Specifying error in simulation is done through commands as the virtual environment. In Future we can test and analyze other network parameters like Reliability.
4. The thesis evaluates UDP and TCP traffic class in a heterogeneous environment. In future the work can be done on various other newer traffic classes like TCP based multimedia, HTTPs and email exchange protocols like POP and SMTP.

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