Chapter 7

Model-4: IAQM-TA-QZ

7.1 Introduction

Without fixed topology / infrastructure, the mobile ad hoc network (MANET) comprises of different communicating nodes and networking equipment. Such elements of MANET traditionally interact with each other via wireless means of communication. The latency existed in this arrangement at every intermediate node, culminating in lengthy delays and packet failure, thereby degrading the overall efficiency of the entire network. Effective Active Queue Management [AQM], such as Random Early Detection [RED], is one of the ways to control this bottleneck. Using RED implies a great deal of ambiguity since it relies heavily on values of defined parameters that extract the average queue length. This **Model-4: An Innovative Active Queue Management Model Through Threshold Adjustment Using Queue Size (IAQM-TA-QZ)** provides an algorithm that changes the threshold parameters and likelihood of packet decrease according to the current traffic load. The suggested solution would be followed by an adaptive mechanism to change the criteria for the RED queue thresholds to better control the average queue duration. The key point is that this approach would definitely increase the efficiency of the network over the standard RED system when traffic load varies and the queue length will be adjusted accordingly.

In this model, an attempt has been made to make some changes in design and practical effects of enhanced successful queue control to tackle time delay schemes by adopting threshold adjustment that can help to maintain proper queue size.

7.2 Motivation and Objectives of Model-4: IAQM-TA-QZ

To overcome the problem related to heavy traffic load, we have proposed Model-4: IAQM-TA-QZ. The simple fundamental theory of this approach is that by measuring the average queue length, the router will feel the congestion. The router alerts the sender node until the network overload has arisen. To encourage the source to change the packet transmission rate to prevent queue overload and network congestion. Two measures consist of the RED algorithm. In the first step, the total queue duration is determined and in the second step packet's drop likelihood is calculated . It is used to assess whether or not packets are lost, and is the signal of network overload whenever packet drop occurs.

The main motivation and objective of the proposed work are to improve the performance of RED by making some modifications to obtain an innovative Active Queue Management model. For this threshold adjustment mechanism using queue size has been adopted.

7.3 Proposed Scheme: Model-4: IAQM-TA-QZ

With regard to network congestion, RED algorithm parameters are dynamically modified in the proposed framework. In order to increase network efficiency without any improvement in the simple RED algorithm features, like throughput, PDR (packet distribution ratio), good output and end-to - end delay, RED parameters are modified with respect to the change in network congestion. This algorithm steadily updates the highest threshold value (Max_{th}) to the maximum level of usable size of queue for reducing wait along with use of complete queue duration.

RED is bound to use set window sizes regardless of fixed threshold parameters (Min_{th} and Max_{th}). The suggested framework consists of a variable size window that dynamically changes the threshold parameters of Min_{th} and Max_{th} to maintain the size of the window small. So, if the size of the window is small, it easily reacts to each and every packet that has arrived. The estimation of the packet drop probability is the same as in the RED algorithm. Here are the main points:

Main feature of the proposed Mode-: IAQM-TA-QZ

- This algorithm (IAQM-TA-QZ) slowly adjusts the maximum threshold value to the maximum level of available queue size.

- In order to maintain the window size minimal, the suggested strategy utilises variable window sizes to dynamically change the minimum and maximum threshold parameters.

- The estimation of the packet drop probability is the same as in the RED algorithm..

7.3.1 Algorithm: Model-4 IAQM-TA-QZ

The proposed algorithm can be divided into three main steps:
First, compare Max_{th} and Avg (average queue size) in stage 1 and then compare Max_{th} with queue size. If Avg is greater than Max_{th}, then compare Max_{th} with queue size and if node queue size is greater than Max_{th}, then Max_{th} is incremented by 1, else the packet drop probability (PDP) is set to 1. In Steps 2, if Avg is greater than Min_{th} and less than Max_{th}, then measure the difference in threshold (Th_{diff}).If Th_{diff} is equal to or greater than half of the queue duration, then calculate $Mid = (Min_{th} + Max_{th})/2)$ and if Avg is less than Mid then decrease both threshold values by one else increase both parameters and determine the likelihood of packet decline. In the last step, if Avg is smaller than or equivalent to Min_{th}, the threshold discrepancy (Th_{diff}) is determined and the likelihood is set to 0. If Th_{diff} is greater than or equal to half the queue duration, then Max_{th} is decreased by one and the probability is calculated. As with the RED mechanism, the calculation of p (probability) is identical.

7.4 Results and Comparison of Model-4: IAQM-TA-QZ

We used NS-2 to illustrate the simulation of the proposed algorithm, the algorithm explores the effects of MANETs with the usage of RED and Efficiency Improved RED. The following parameters are used for assessing network performance, average end-to - end latency, packet distribution ratio, network throughput and good output.

Data obtained after doing some experiments using ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and IAQM-TA-QZ are analyzed to study the performance of each model with respect to the parameters: End-to- End delay, Packet delivery ratio, Throughput and Goodput, By comparing their results with that of the existing RED, the best Model can be selected to improve the performance RED.

The simulation is performed with 100 nodes and the proposed paths are selected randomly. The Table 7.1 shows the performance measurement of the proposed IAQM-TA-QZ scheme with various no of nodes from 2 to 100. In this experiments end to end delay varies from 331 to 156.I

Algorithm 7.1: Algorithm of IAQM-TA-QZ

input : Initialize the nodes

output: Congestion will be control with high throughput and lesser packet drop ratio and end to end delay.

```
// In the first step, MaximumThreshold and AVG is compared and if AVG is more than
   MaximumThreshold then MaximumThreshold is compared with queue size.  If queue size is
   greater than MaximumThreshold, then new MaximumThreshold and Probability is
   calculated.  Otherwise the Probability is set to 1.
if (AVG > MaximumThreshold ) then
    if (MaximumThreshold < queue_size) then
        MaximumThreshold = MaximumThreshold + 1;
        P = calculate new P ;
    else
        P = 1;
    end
    // In the second step, if AVG is in between minimum and maximum threshold, then
       threshold deference is calculated.  If the threshold difference is greater than
       the half of queue size, new minimum and maximum threshold is calculated;
else if (MinimumThreshold < AVG <= MaximumThreshold) then
    if ( ThresholdDiff >= queue_size/2 ) then
        mid = (MaximumThreshold + MinimumThreshold )/2;
        if (AVG < mid) then
            MaximumThreshold and MinimumThreshold are decreased;
        else
            MaximumThreshold and MinimumThreshold are increased;
            P = new P is calculated;
        end
    end
    // In the third step, if AVG is less than or equal to minimum threshold, then
       threshold difference is calculated.  If the threshold difference is less than half
       of queue_size, then the probability is set to 0, otherwise new maximum threshold
       and probability is calculated:
else if (AVG <= MinimumThreshold) then
    if ( ThresholdDifference >= queue_size/2) then
        MaximumThreshold = MaximumThreshold - 1;
        P = new P is calculated;
    else
        P = 0;
    end
end
```

depends on the number of nodes. When number of node increases in then end to end delay of the network decreases. Packet delivery ratio also decreases, but throughput and goodput increases depending on the increase of input node.

End to End Delivery: The ratio of packet received time to packet send time is termed as end

Table 7.1: *Experimental results of IAQM-TA-QZ*

Nodes	End-to-End Delay	Packet Delivery Ratio	Throughput	Goodput
2	328.365	90.32	711.35	345.32
10	296.265	87.32	716.35	365.76
25	199.354	93.24	731.24	370.13
50	172.264	90.21	750.36	380.29
75	169.369	90.48	748.32	385.64
100	153.258	88.36	748.79	390.65

to end delay. The end to end delay should be low in order to provide better performance. The Table 7.2 and Graph Fig. 7.1 shows the performance of routing end to end delay in continuous traffic pattern for ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED, IAQM-TA-QZ and RED.

In the proposed IAQM-TA-QZ, by virtue of active queue management, the packet moves smoothly with a little bit loss. Here, congestion can be avoidable and packet can be delivered within time with increasing mode. Thus the proposed IAQM-TA-QZ performed better with low end to end delay when compared with existing scheme.

Table 7.2: *End-to-End Delay of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and IAQM-TA-QZ*

Nodes	RED	ADWD-RED-IP	AQM-RED-RPL	PAQM-RS-RED	IAQM-TA-QZ
2	335.446	340.235	333.235	331.364	328.365
10	304.878	312.674	301.539	299.365	296.265
25	206.093	208.443	204.326	202.652	199.354
50	179.589	184.385	177.328	175.365	172.264
75	177.267	180.438	175.214	172.621	169.369
100	161.335	163.275	158.325	156.251	153.258

In this approach, congestion can be avoided and packet can be delivered within time while increasing no of nodes. Thus, the proposed IAQM-TA-QZ, performance better with low end to end delay when compared to existing RED scheme.

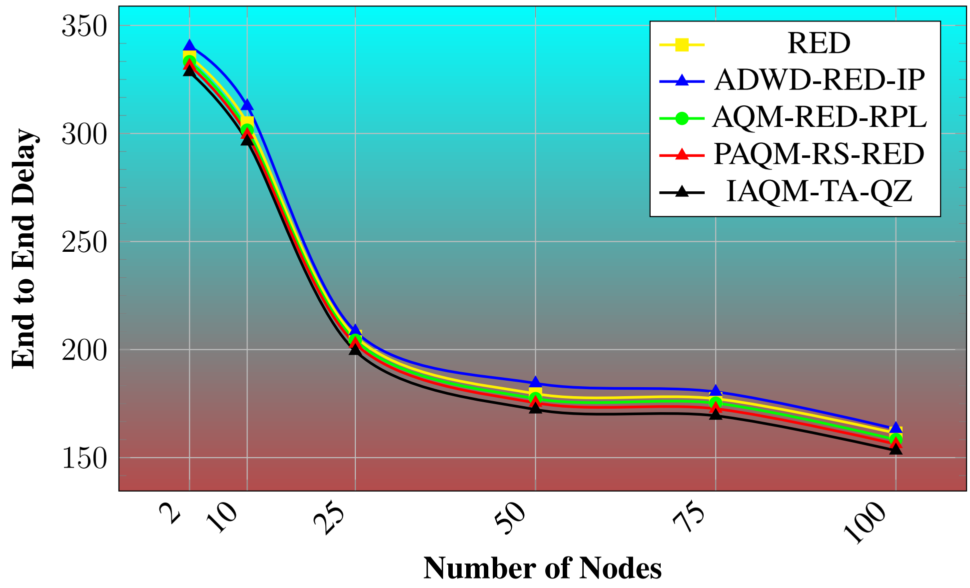

Figure 7.1: *Comparison of proposed schemes with respect to End to End delay*

Table 7.3: *Packet Delivery Ratio of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED, and IAQM-TA-QZ*

Nodes	RED	ADWD-RED-IP	AQM-RED-RPL	PAQM-RS-RED	IAQM-TA-QZ
2	91.21	89.67	90.32	91.67	89.95
10	86.86	84.43	87.32	86.36	85.63
25	92.77	87.56	93.24	92.36	90.51
50	91.64	89.29	90.21	91.52	90.21
75	90.22	88.97	90.48	89.36	89.37
100	88.63	87.35	88.36	87.55	88.12

Packet Delivery Ratio: Packet delivery ratio is defined as the ratio of total numbers of packet send to the total number of packets received. The results are presented in Table 7.3 and the corresponding graphical representation is depicted in Fig. 7.2. The Fig. 7.2 represents the routing packet delivery ratio for existing RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and IAQM-TA-QZ algorithm with respect to the number of nodes. Due to active queue management of IAQM-TA-QZ, it is possible to receive more packets without any loss, and the proposed IAQM-TA-QZ algorithm achieves high packet delivery ratio than RED and gives better result.

Throughput: Throughput is one of the important parameters for evaluating the performance

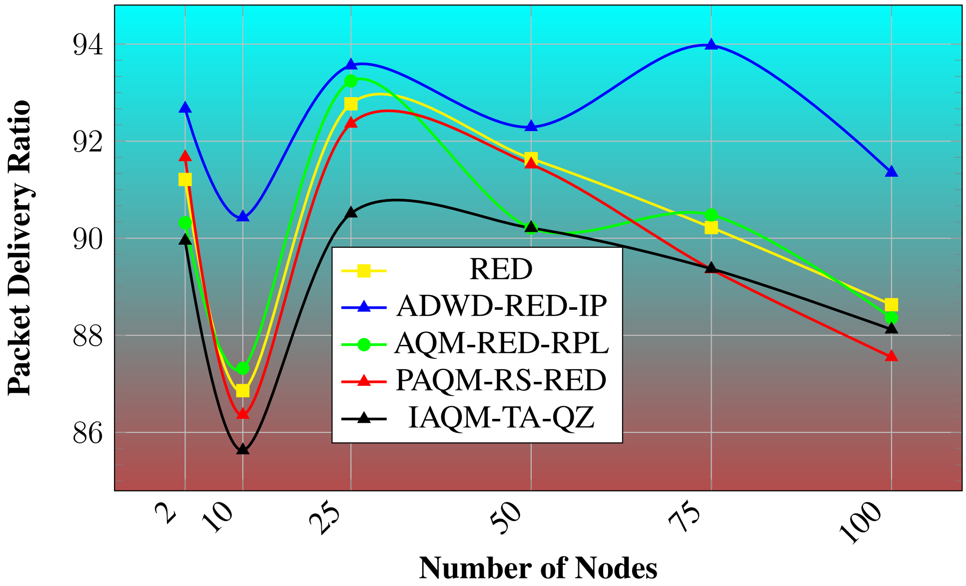

Figure 7.2: *Comparison of proposed schemes with respect to packet delivery ratio*

of a network. The throughput is calculated based on number of bits transmitted per second. In order to provide better performance of the network the system throughput must be high. The simulated results are shown in Table 7.4 and corresponding graph (Fig. 7.3) shown the performance comparison for RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and IAQM-TA-QZ. It is analysed from the graph that, the throughput for the IAQM-TA-QZ is gradually increasing when compared to the existing RED. Therefore, the proposed IAQM-TA-QZ gives better throughput without loss.

Table 7.4: *Throughput of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and IAQM-TA-QZ*

Nodes	RED	ADWD-RED-IP	AQM-RED-RPL	PAQM-RS-RED	IAQM-TA-QZ
2	709.48	710.23	711.35	712.36	716.25
10	712.79	715.54	716.35	720.61	722.56
25	726.55	728.25	731.24	736.29	737.56
50	748.08	750.67	750.36	755.62	759.81
75	746.54	752.45	748.32	750.27	755.24
100	745.26	753.45	748.79	757.63	759.87

Goodput: In the Computer Network, goodput is defined as the number of useful information delivered by a network to a certain node per unit of time. The goodput is always lower than the throughput due to overhead and lost or dropped packet for congestion. Table 7.5 shows

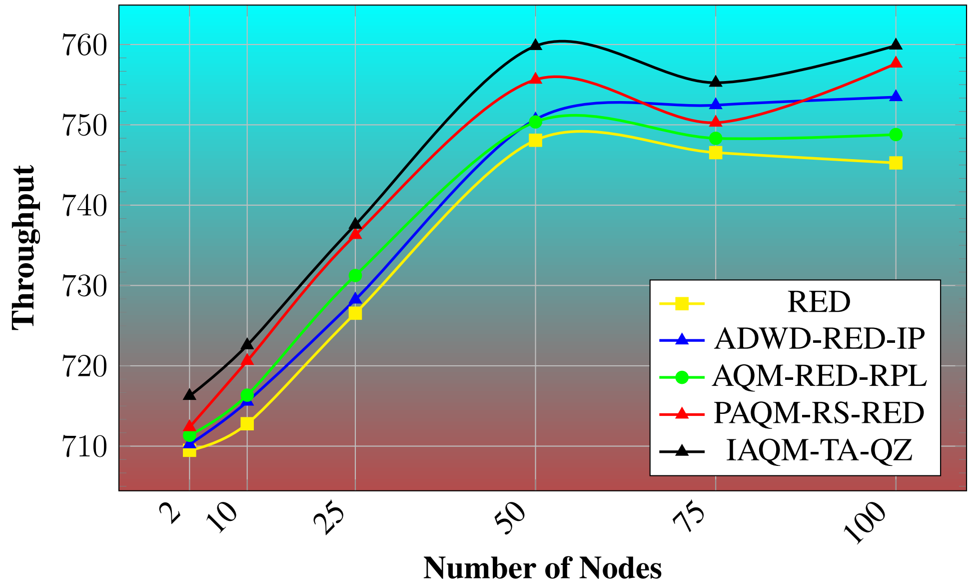

Figure 7.3: *Comparison of proposed schemes with respect to Throughput*

the goodput comparison among RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and IAQM-TA-QZ. In the proposed IAQM-TA-QZ, the goodput is better than RED based algorithms because the packet drop function has been changed for the active queue management. The corresponding graph is presented in Fig. 7.4. The explanation, why IAQM-TA-QZ has lower delay and jitter is that because it is appropriate to forward or drop a packet that enters the router buffer without staying in the router buffer anymore.

Table 7.5: *Goodput of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and IAQM-TA-QZ*

Nodes	RED	ADWD-RED-IP	AQM-RED-RPL	PAQM-RS-RED	IAQM-TA-QZ
2	337.85	388.76	345.32	401.43	406.83
10	355.04	408.32	365.76	423.77	429.01
25	367.21	431.45	370.13	456.96	464.23
50	374.04	455.39	380.29	478.39	481.57
75	377.04	462.68	385.64	479.76	482.06
100	382.18	478.49	390.65	487.29	493.04

Table 7.6 presents the comparison of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and IAQM-TA-QZ in terms of number of packet received, forwarded, dropped and loss rate for flows 20, 40, 60, ... 200 nodes. Here, packet loss rate is lower then RED due to active queue management with introducing MIN_q and MAX_q parameters. The corresponding graph

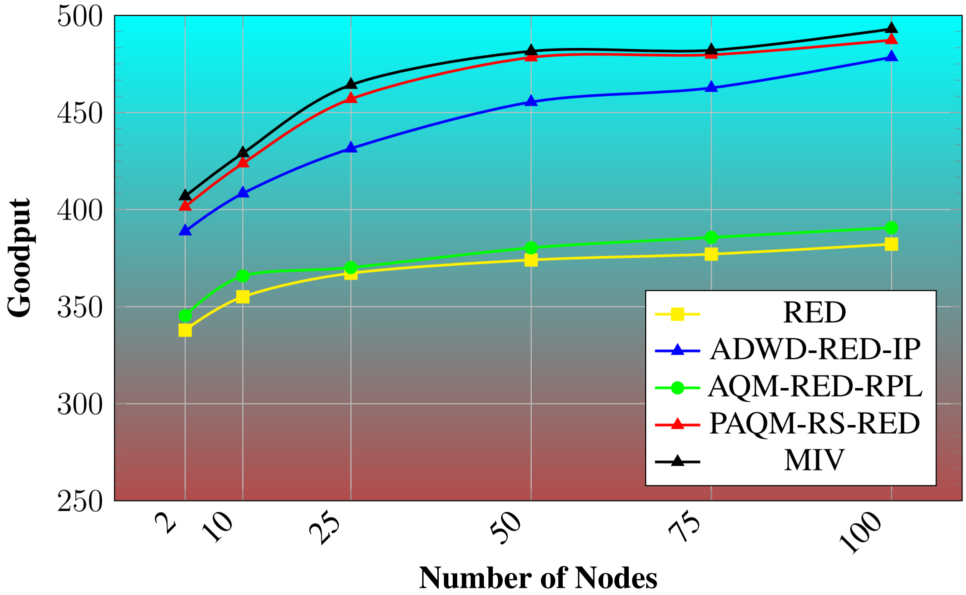

Figure 7.4: *Comparison of proposed schemes with respect to Goodput*

shows that the IAQM-TA-QZ improves the performance of RED algorithm.

Table 7.6: *Analysis of the proposed scheme in terms of the number of packets received, forwarded, dropped, and packet loss rate for flows 20,40,60, ..., 200*

Algorithms	Packets received	Packets sent	Packets dropped	Packet Loss Rate	Throughput
RED	8487	8018.643	463.4286	0.0612	1.170581
ADWD-RED-IP	8357.231	8565.617	208.386	0.0243	1.124935
AQM-RED-RPL	8370.143	8155.071	206.3571	0.0235	1.192354
PAQM-RS-RED	8631.714	8428.428	203.286	0.0235	1.154119
IAQM-TA-QZ	8780.714	8579.540	200.892	0.0229	1.173448

7.5 Summary of the Model-4: IAQM-TA-QZ

There are many methods developed for improving the performance of RED as suggested by different researchers. We have developed different models to improve the performance of existing RED by considering various parameters. In our case, IAQM-TA-QZ can be applied to improve the performance of RED by adopting AQM with threshold adjustment using queue size. Other models have their own advantages and disadvantages and they are specific parameters sensitive.

In this model-4 IAQM-TA-QZ, a new algorithm named An Innovative Active Queue Management Model Through Threshold Adjustment Using Queue Size has been proposed for successful queue management in the MANET. To change threshold parameters by using queue length, we use a dynamic adjustment policy. In NS 2, we evaluate this algorithm and compared with the RED algorithm. The results indicates that our output is better than RED in the context of efficiency parameters of the network those are throughput, PDR and end to end delay. Increased RED output adjusts the queue duration and eliminates the uncertain network load in that network where network flow varies from time to time.