Chapter 6

Model-3: PAQM-RS-RED

6.1 Introduction

The active queue management (AQM) algorithm helps to accomplish both high performance and low packet delay concurrently. The related performance queuing delay, conversely, is somewhat attuned to the load, and is thus not predictable in due course.

Our aim is to solve the issue by developing minor adjustments to the RED algorithm as a whole. Although keeping the general premise intact, we create various algorithmic alterations to this concept and then analyse its output using simulation. We consider that our proposed **Model-3: A Predictable Active Queue Management to Reduce Sensitivity of RED Parameter (PAQM-RS-RED)**, that can also be incorporated as a clear demonstration in under RED routers, eliminates the sensitivity to variables that influence the functioning of RED and in a broad range of traffic situations can reach a clearly defined target average queue length. Based on a comprehensive experiments, we think this is robust enough for router implementation.

There are several proposals for active queue management schemes to avoid these problems. In this approach, an attempt has been made to develop an algorithm to improve the performance of RED by reducing the sensitivity by means of a predictable Active Queue Management technique keeping its original structure. Here, we have proposed **Model-3: A Predictable Active Queue Management to Reduce Sensitivity of RED Parameter (PAQM-RS-RED)** to achieve better results with respect to packet loss and good put.

6.2 Motivation and Objectives of Model-3: PAQM-RS-RED

The key motivation and goals of this work are to boost the efficiency of RED through a predictable Active Queue management technique by reducing its vulnerability specifications. For ADWD-RED-IP, AQM-RED-RPL and PAQM-RS-RED have been tested with respect to End to End delay and their performances are compared with original RED for the same parameters. Our objective is to make comparative studies with respect to delivery ratio, throughput, goodput, packet received, packet sent, packet dropped, packet loss rate for different number of nodes present in the system. To achieve the above objective, following points have been considered:

- In the previously designed RED-based algorithms with a larger number of long-lived flows suffer poor throughput. It was found that increasing the number of flows reduces the use of connections, and that MAX_p results in lower lengths of queues.
- In addition, when MAX_p is limited compared to the steady-state packet drop rate and the normal packet drop rate, it has been found that throughput suffers.
- The queue size often reaches the packets' MAX_p weight. Thus, with RED, achieving strong throughput and acceptable average queue lengths allows both W_p and MAX_p to be carefully tuned. It is this cautious tuning that is supposed to be achieved automatically by PAQM-RS-RED.
- Lastly, it has been found that in order to achieve efficient high throughput, it is required to preserve its average queue size within the predefined goal range.

6.3 Proposed Scheme: Model-3: PAQM-RS-RED

A Predictable Active Queue Management to Minimize RED Parameter Sensitivity (PAQM-RS-RED) overall guidance as applied here are the similar as all those suggested by Feng et al. [15] for the initial Adaptive RED i.e. adapting MAX_p to preserve the average queue between MIN^{th} and MAX^{th}. Our solution varies in three respects from the initial Adaptive RED suggested by Feng et al. [15]:

The main feature of the proposed Model-3: PAQM-RS-RED

- The overall probability is not only balanced to preserve the average queue size between its maximum and minimum thresholds. It also tries to keep it halfway between (MIN^{th}) and (MAX^{th}).
- Maximum probability is tried to keep within the range [0.01 , 0.50]. It is adapted slowly and in small steps.
- Instead of multiplicative increase and decrease the maximum probability, the scheme uses additive-increase and multiplicative-decrease.

6.3.1 Algorithm: Model-3: PAQM-RS-RED

This algorithm is queue based and it is able to control the congestion. The algorithm works for each interval seconds and check the average (AVG) value. If $((AVG > target)$ and $(MAXp <= 0.50)$ then $MAXp$ is increased additively increase that is $MAXp = MAXp+C1$ otherwise if $(MAXp >= 0.01)$ then $MAXp$ is decreased as multiplicative that is $MAXp = MAXp \times C2$. The other parameters are as follows: Interval is 0.50 seconds, target = [MinimumThreshold + 0.4 $\times$ (MaximumThreshold - MinimumThreshold), to MinimumThreshold + 0.6 $\times$ (MaximumThreshold - MinimumThreshold)], $C1 = MIN(0.01, MAXp/4)$ and $C2 = 0.90$. The details are enlisted in Algorithm of PAQM-RS-RED.

Algorithm 6.1: Algorithm of PAQM-RS-RED

input : Initialize the nodes.

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

```
for each interval seconds do
    if ((AVG > target) and (MAXp <= 0.50)) then
        // MAXp is increased additive-increase
        MAXp = MAXp + C1;
    else if (MAXp >= 0.01) then
        // MAXp is decreased (multiplicative-decrease)
        MAXp = MAXp * C2;
    end
    // In this algorithm:
    interval is 0.50 seconds
    target = [MinimumThreshold + 0.4 * (MaximumThreshold - MinimumThreshold), MinimumThreshold + 0.6 *
    (MaximumThreshold - MinimumThreshold)]
    C1 = MIN (0.01, MAXp/4);
    C2 = 0.90;
end
```

6.4 Results and Comparison of Model-3: PAQM-RS-RED

In this section, the proposed Model-3: PAQM-RS-REDis compared with existing RED. It is observed that this PAQM-RS-REDbased algorithm is very effective in terms of performance metric: throughput, end to end delay, packet delivery ratio and goodput.

The simulation is performed with 100 nodes and the proposed path selection take random. The table 6.1 shows the performance measurement of the proposed PAQM-RS-RED scheme with various no of nodes from 2 to 100. In this experiments, end to end delay varies from 331 to 156 and it depends on the number of nodes. When number of node increases in the network then end to end delay decreases. Packet delivery ratio also decreases, but throughput and goodput increases depending on the increase of input node.

Table 6.1: *Experimental results of PAQM-RS-RED*

Nodes	End-to-End Delay	Packet Delivery Ratio	Throughput	Goodput
2	331.235	90.32	711.35	345.32
10	299.539	87.32	716.35	365.76
25	202.326	93.24	731.24	370.13
50	175.328	90.21	750.36	380.29
75	172.214	90.48	748.32	385.64
100	156.325	88.36	748.79	390.65

End to End Delay: The ratio of packet received time to packet send time is termed as end to end delay. The end to end delay should be low in order to provide better performance. The Table 6.2 and graph Fig. 6.1 shows the performance of routing end to end delay in continuous traffic pattern for ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED and RED.

In the proposed PAQM-RS-RED, with active queue management, the packet moves smoothly with a little bit loss. Here, congestion can be avoidable and packet can be delivered within due time with increasing mode. Thus, the proposed PAQM-RS-RED performed better with low end to end delay when compared with existing scheme.

Packet Delivery Ratio: Packet delivery ratio is considered as the ratio of total numbers of packet send to the total number of data packets achieved. The results are shown in Table 6.3 and the corresponding graphical representation is shown in Fig. 6.2. The Fig. 6.2 represents the routing packet delivery ratio for existing RED, ADWD-RED-IP, AQM-RED-RPL and PAQM-RS-RED algorithm with respect to the number of nodes. Due to active queue management of PAQM-RS-RED, it is possible to receive more packet without any loss, and the proposed PAQM-RS-RED algorithm achieves high packet delivery ratio than RED and gives better results.

Table 6.2: *End-to-End Delay of RED, ADWD-RED-IP, AQM-RED-RPL and PAQM-RS-RED*

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

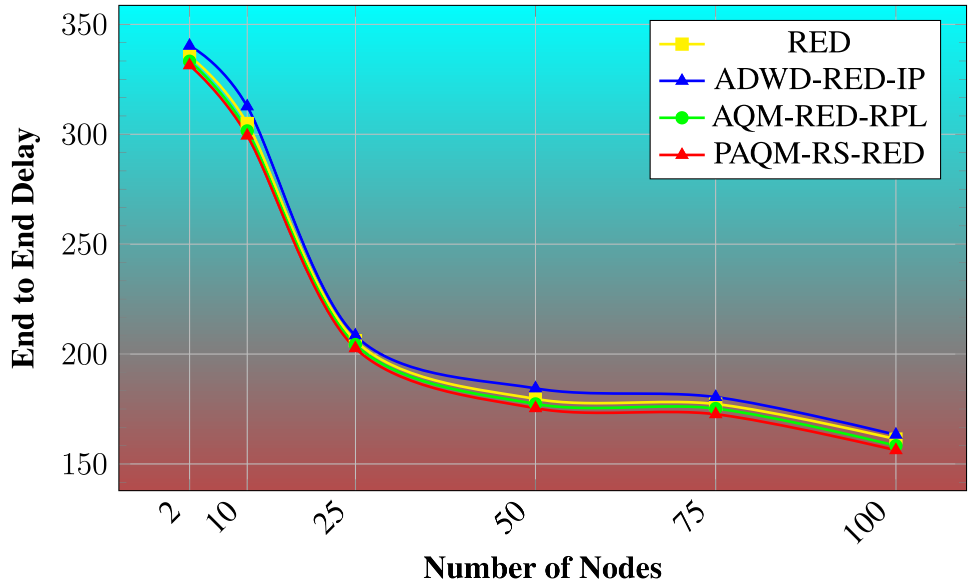

Figure 6.1: *Comparison of proposed schemes with respect to End to End Delay*

Table 6.3: *Packet Delivery Ratio of RED, ADWD-RED-IP, AQM-RED-RPL and PAQM-RS-RED*

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

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

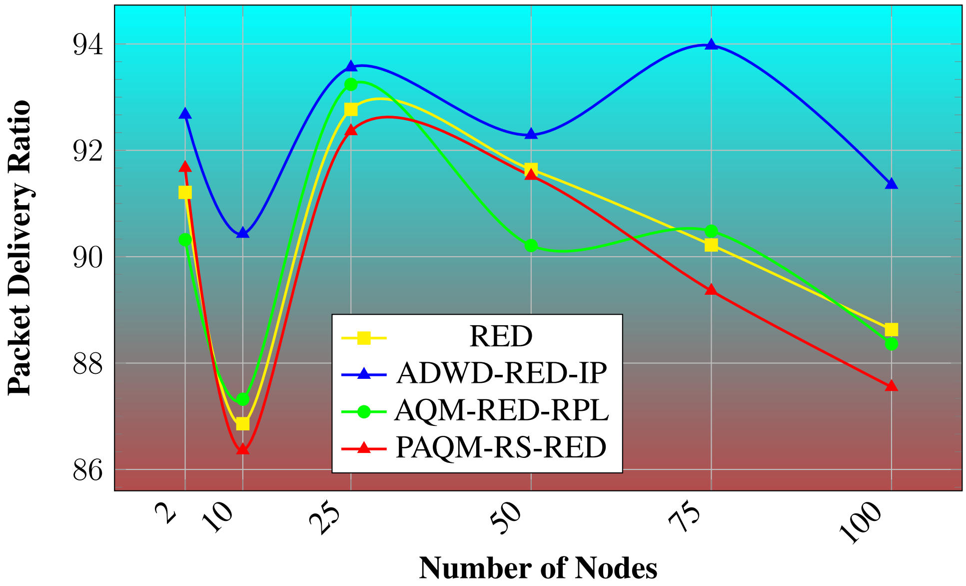

Figure 6.2: *Comparison of proposed schemes with respect to packet delivery ratio*

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 6.4 and corresponding graph (Fig. 6.3) is shown the performance comparison for RED, ADWD-RED-IP, AQM-RED-RPL and PAQM-RS-RED. It is analysed from the graph that, the throughput for the PAQM-RS-RED is gradually increasing compared to the existing RED. Therefore, the proposed PAQM-RS-RED gives better throughput without loss.

Table 6.4: *Throughput of RED, ADWD-RED-IP, AQM-RED-RPL and PAQM-RS-RED*

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

Goodput: In the MANET, goodput is the number of useful information delivered to a certain node per unit time. The goodput is always lower than the throughput due to overhead and lost or dropped packet for congestion. Table 6.5 shows the goodput comparison among RED, ADWD-

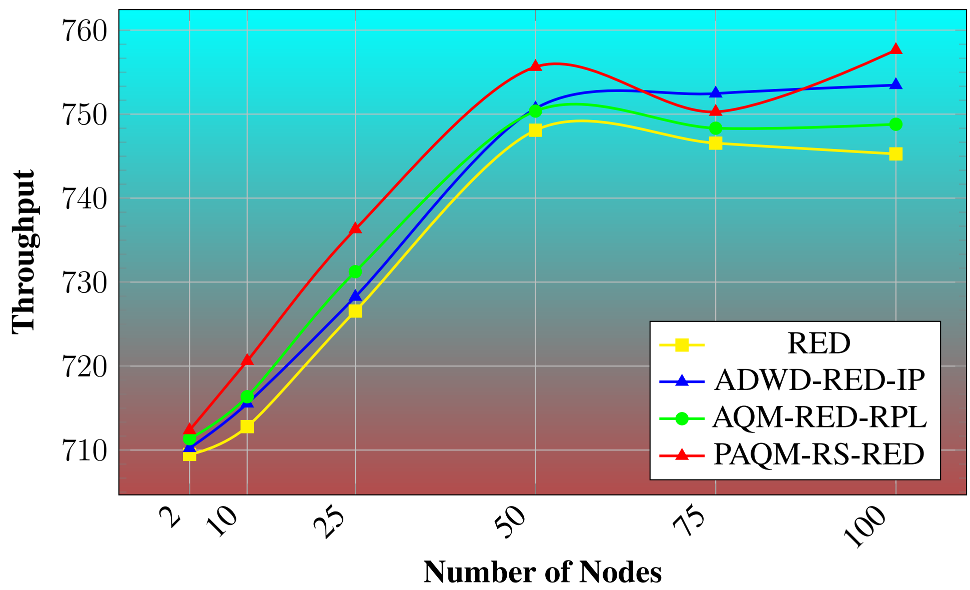

Figure 6.3: *Comparison of proposed schemes with respect to Throughput*

RED-IP, AQM-RED-RPL and PAQM-RS-RED. In the proposed PAQM-RS-RED, the goodput is better than RED based algorithms because the packet drop function has been changed which has been used for the active queue management. The corresponding graph is presented in Fig. 6.4. The explanation why PAQM-RS-RED has lower delay and jitter than rest algorithms is because it is appropriate to forward or drop a packet that enters the router buffer without staying in the router buffers anymore. There are less delay and jitter values for PAQM-RS-RED than for SRED, REM, BLUE and LDC algorithms. Delaying and Jittering Parameter values are lower enough to use PAQM-RS-RED on intermediate routers for real-time applications such as UDP.

Table 6.5: *Goodput of RED, ADWD-RED-IP, AQM-RED-RPL and PAQM-RS-RED*

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

Table 6.6 represents the comparison of RED, ADWD-RED-IP, AQM-RED-RPL and PAQM-RS-REDin terms of number of packet received, forwarded, dropped and loss rate for flows 20,

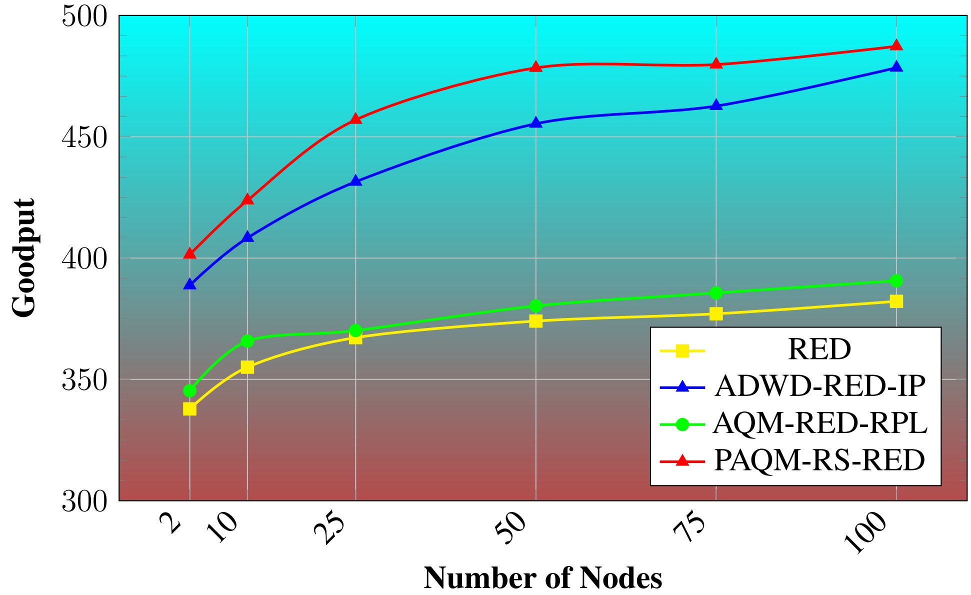

Figure 6.4: *Comparison of proposed schemes with respect to Goodput*

40, 60, ... 200 nodes. Here packet loss rate is lower then RED due to active queue management with introducing parameters are as follows: Interval is 0.50 seconds, target = [MinimumThreshold + 0.4 × (MaximumThreshold - MinimumThreshold), to MinimumThreshold + 0.6 × (MaximumThreshold - MinimumThreshold)], $C1 = MIN(0.01, MAXp/4)$ and $C2 = 0.90$.

Table 6.6: *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

6.5 Summary of the Model-3: PAQM-RS-RED

The RED based algorithm helps MANET to reach high throughput and low average latency concurrently. The resulting average queue size, though, is the congestion level and the settings of the RED parameter, and thus, it is not understandable in advance. Naturally, system speculators would prefer to provide a harsh analytical estimation of the average holds in their jammed routers, as a major element of the level of service provided to their customers. To obtain such inevitable average detains with RED, continuous tuning of variable would be appropriate to conform to actual traffic disciplines. In such situation we have formulated and adjust new parameter setting as follows: Interval is 0.50 seconds, target = [MinimumThreshold + 0.4 $\times$ (MaximumThreshold - MinimumThreshold), to MinimumThreshold + 0.6 $\times$ (MaximumThreshold - MinimumThreshold)], $C1 = MIN(0.01, MAXp/4)$ and $C2 = 0.90$.

We have proposed a priority queue based AQM scheme called Active Queue Management in RED for A Predictable Active Queue Management to Reduce Sensitivity of RED Parameter (PAQM-RS-RED), In order to determine the probability of falling and labelling a packet to reduce the impact of network congestion, it uses the packet arrival rate and queue size. Compared to the previous RED AQM schemes, which suggests that our Predictable Active Queue Management to Minimize RED Parameter Sensitivity (PAQM-RS-RED) algorithm not only outperforms the other schemes by achieving lower packet loss rate and greater good positioning. But it is often more robust to complex workloads to retain a secure queue. Queue reliability is a good function of an AQM policy since it tends to lower the risk of packet failure. The simulation results shows the better performance of the proposed algorithm by reducing delay. In addition to high packet delivery ratio is achieved, it is not increasing the overhead significantly. For this analysis, we have used the NS-2 simulation application. The NS-2 simulator produces a rather comparable traffic load to the actual network. We believe that if we understand this analysis in the real world, we will get better results. We expect to equate PAQM-RS-RED with more recently built AQM algorithms with actual data parameters obtained from specific environments in future work.