Chapter 10

Conclusions and Future Scope

In this dissertation, six new congestion control models (Model-1: ADWD-RED-IP, Model-2: AQM-RED-RPL, Model-3: PAQM-RS-RED, Model-4: IAQM-TA-QZ, Model-5: CCA-BO-RED, Model-6: AQM-RED-CPTQ) have been introduced. A summary of experimental results and achievements are also discussed in this chapter. Some limitations and promising directions for future work are also elaborated.

10.1 Summary of the Proposed Work

In this thesis, six new congestion control routing algorithms have been proposed to solve the Active Queue Management (AQM) problem in MANET. The proposed algorithms based on Random Early Detection (RED), which is one of the most widely used algorithms for successful Queue Management (AQM). A new parameter is used to set RED parameters dynamically. The comparative results of all proposed models (Model-1: ADWD-RED-IP, Model-2: AQM-RED-RPL, Model-3: PAQM-RS-RED, Model-4: IAQM-TA-QZ, Model-5: CCA-BO-RED, Model-6: AQM-RED-CPTQ) considering End-to-End delay with RED algorithm has been presented in the Table 10.1.

Table 10.1: *End-to-End Delay of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED, IAQM-TA-QZ, CCA-BO-RED and AQM-RED-CPTQ*

End-to-End Delay of RED and proposed models							
Nodes	RED	ADWD-RED-IP	AQM-RED-RPL	PAQM-RS-RED	IAQM-TA-QZ	CCA-BO-RED	AQM-RED-CPTQ
2	335.446	340.235	333.235	331.364	328.365	326.754	325.369
10	304.878	312.674	301.539	299.365	296.265	294.352	291.258
25	206.093	208.443	204.326	202.652	199.354	196.258	193.369
50	179.589	184.385	177.328	175.365	172.264	170.541	167.364
75	177.267	180.438	175.214	172.621	169.369	166.365	162.357
100	161.335	163.275	158.325	156.251	153.258	150.258	148.365

The Table 10.1 represents the summary of results on the basis of the parameter: End-to-End delay given by all the models when 2, 10, 25, 50, 75 and 100 number of nodes are considered in the system. From the said table it is clear that the End-to-End delay reduces with the increase of number of nodes in the system and our proposed AQM-RED-CPTQ scheme provides best results in terms of the same. It has been observed that the End-to-End delay of our proposed models are lower than RED and AQM-RED-CPTQ have 148.365 when number of nodes are considered 100 in the system. Fig. 10.1 depicts graphical representation of End-to-End delay presented by all the models when only 2 and 100 nodes are considered. From the graphical representation it is noted that AQM-RED-CPTQ scheme gives the less End-to-End delay results when specially 2 and 100 nodes are considered in a system.

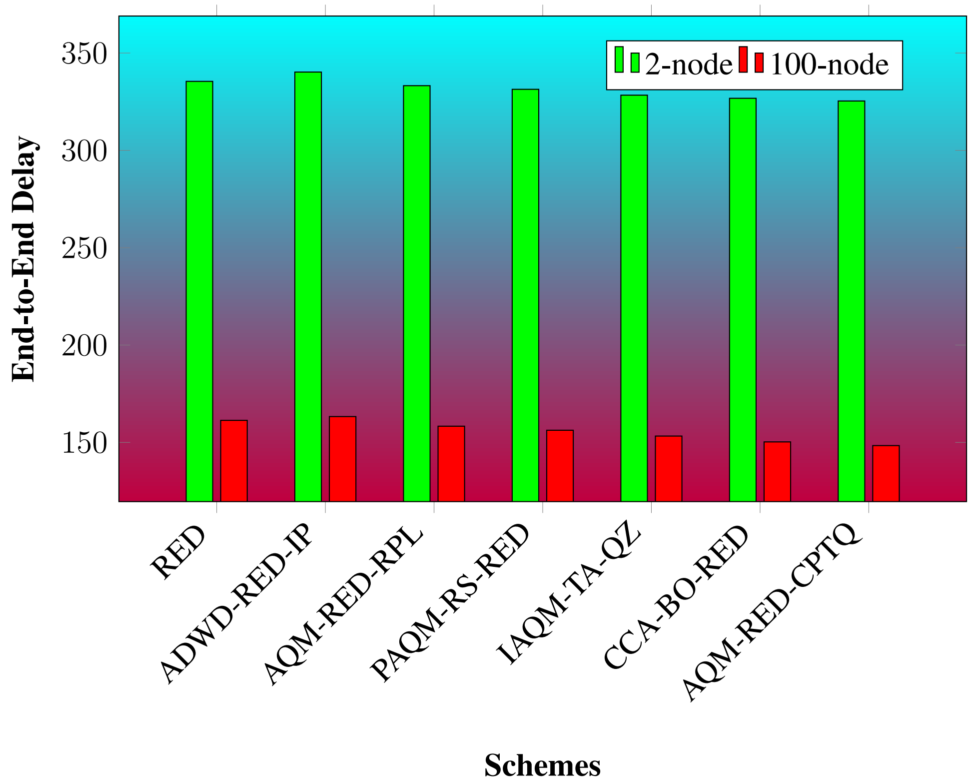

Figure 10.1: *End to End delay when only 2 and 100 number of nodes are considered*

Table 10.2: *Packet delivery ratio of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED, IAQM-TA-QZ, CCA-BO-RED and AQM-RED-CPTQ*

Packet Delivery Ratio of Random Early Detection (RED) and proposed models							
Nodes	RED	ADWD-RED-IP	AQM-RED-RPL	PAQM-RS-RED	IAQM-TA-QZ	CCA-BO-RED	AQM-RED-CPTQ
2	91.21	89.67	90.32	91.67	89.95	92.32	95.36
10	86.86	84.43	87.32	86.36	85.63	87.21	90.78
25	92.77	87.56	93.24	92.36	90.51	93.61	96.37
50	91.64	89.29	90.21	91.52	90.21	92.36	95.38
75	90.22	88.97	90.48	89.36	89.37	91.37	94.51
100	88.63	87.35	88.36	87.55	88.12	89.39	93.27

The Table 10.2 represents the summary of results on the basis of the parameter: packet delivery ratio shown by all the models when 2, 10, 25, 50, 75 and 100 number of nodes are considered in the system. From the said table it is clear that the packet delivery ratio enhanced with the increase of nodes in the system and our proposed AQM-RED-CPTQ scheme provides best results in terms of packet delivery ratio. It has been observed that the packet delivery ratio of our proposed models are higher than RED and AQM-RED-CPTQ scheme has 95.36 and 93.27 when number of nodes are considered 2 and 100 respectively in the system. Fig. 10.2 depicts graphical representation of packet delivery ratio presented by all the models when only 2 and 100 nodes are considered. From the graphical representation it can be noted that AQM-RED-CPTQ scheme gives the less packet delivery ratio delay results when specially 2 and 100 nodes are considered in a system.

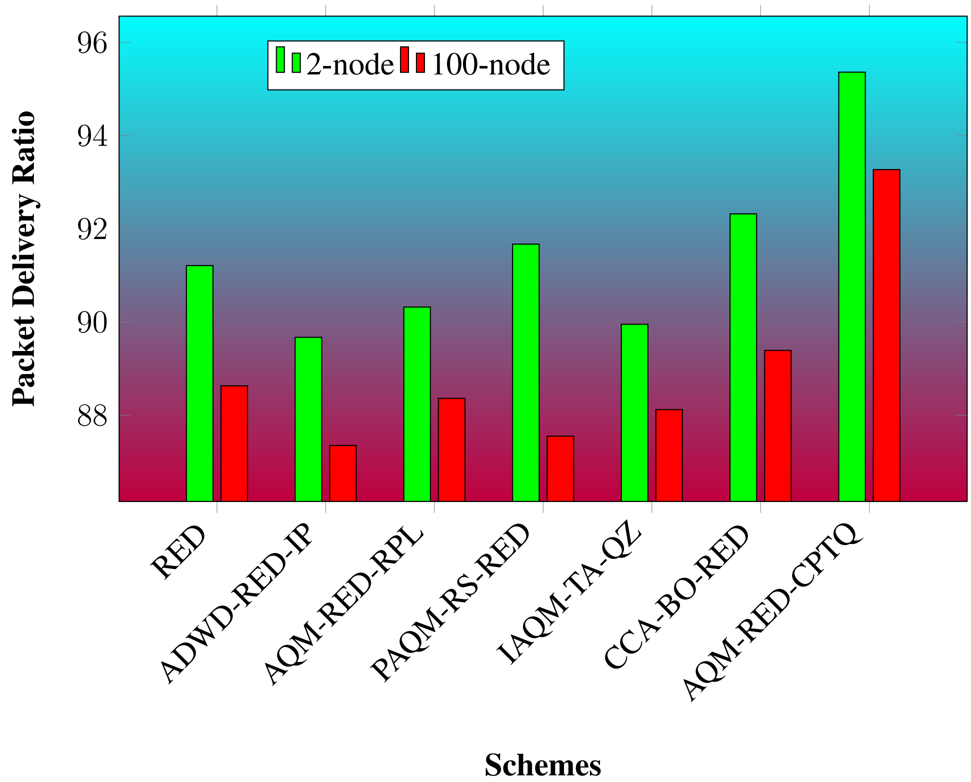

Figure 10.2: *Packet Delivery Ratio when only 2 and 100 number of nodes are considered*

The Table 10.3 presents the summary of results on the basis of the parameter Throughput, obtained from the simulations of all the models when 2, 10, 25, 50, 75 and 100 number of nodes are considered in the system. From the said table it is clear that the Throughput enhanced with the increase of nodes in the system and our proposed AQM-RED-CPTQ scheme provides best results in terms of Throughput. It has been observed that the Throughput results of our proposed models are higher than RED and AQM-RED-CPTQ scheme has 720.56 and 774.83

Table 10.3: *Throughput of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED, IAQM-TA-QZ, CCA-BO-RED and AQM-RED-CPTQ*

Throughput of Random Early Detection (RED) and proposed models							
Nodes	RED	ADWD-RED-IP	AQM-RED-RPL	PAQM-RS-RED	IAQM-TA-QZ	CCA-BO-RED	AQM-RED-CPTQ
2	709.48	710.23	711.35	712.36	716.25	718.54	720.56
10	712.79	715.54	716.35	720.61	722.56	725.36	731.59
25	726.55	728.25	731.24	736.29	737.56	741.39	745.91
50	748.08	750.67	750.36	755.62	759.81	762.57	771.97
75	746.54	752.45	748.32	750.27	755.24	763.17	772.37
100	745.26	753.45	748.79	757.63	759.87	764.52	774.83

when number of nodes are considered 2 and 100 respectively in the system. Fig. 10.3 depicts graphical representation of Throughput presented by all the models when only 2 and 100 nodes are considered. From the graphical representation it is noted that AQM-RED-CPTQ scheme gives the less Throughput results when specially 2 and 100 nodes are considered in a system.

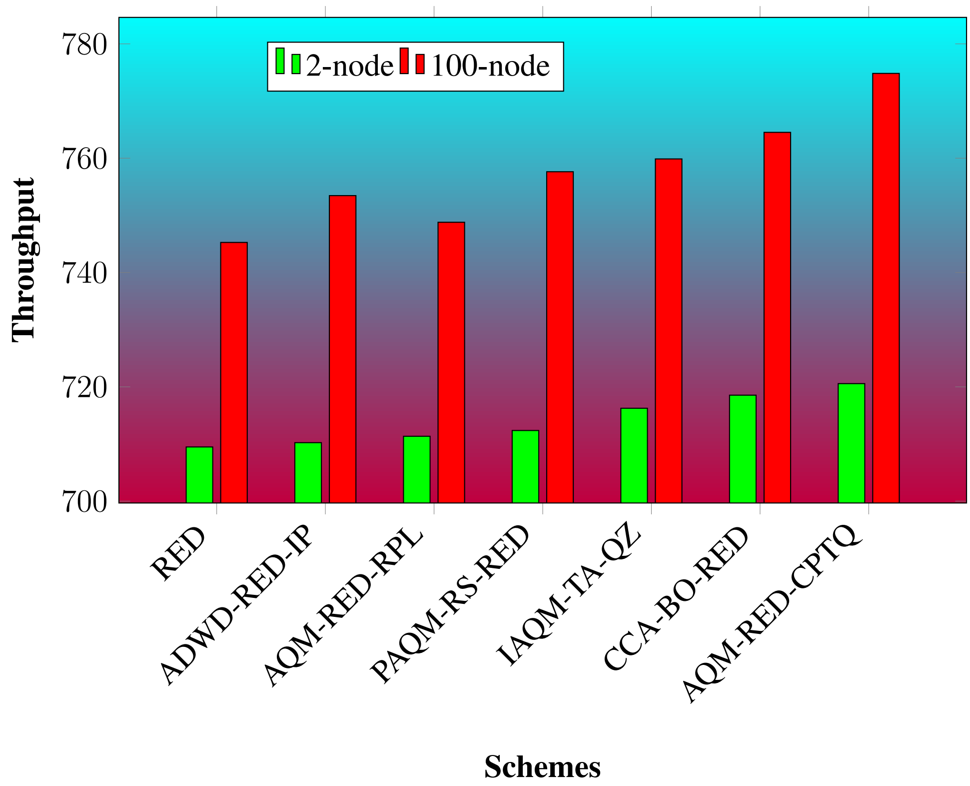

Figure 10.3: *Throughput when only 2 and 100 number of nodes are considered*

The Table 10.4 shows the summary of the results based on the parameter: Goodput, given by all the models when 2, 10, 25, 50, 75 and 100 number of nodes are considered in the system. From the said table it is clear that the Goodput is enhanced with the increase of nodes in the

Table 10.4: *Goodput of RED, ADWD-RED-IP, AQM-RED-RPL, PAQM-RS-RED, IAQM-TA-QZ, CCA-BO-RED and AQM-RED-CPTQ*

Goodput of RED and Performance increased RED							
Nodes	RED	ADWD-RED-IP	AQM-RED-RPL	PAQM-RS-RED	IAQM-TA-QZ	CCA-BO-RED	AQM-RED-CPTQ
2	337.85	388.76	345.32	401.43	406.83	411.86	417.08
10	355.04	408.32	365.76	423.77	429.01	432.61	438.42
25	367.21	431.45	370.13	456.96	464.23	469.63	473.03
50	374.04	455.39	380.29	478.39	481.57	485.76	490.71
75	377.04	462.68	385.64	479.76	482.06	487.65	493.05
100	382.18	478.49	390.65	487.29	493.04	498.46	502.67

system and our proposed AQM-RED-CPTQ scheme provides best results in terms of Goodput. It has been observed that the Goodput of our proposed models are higher than RED and AQM-RED-CPTQ scheme has 417.08 and 502.67 when number of nodes are considered 2 and 100 respectively in the system. Fig. 10.4 depicts graphical representation of Goodput presented by all the models when only 2 and 100 nodes are considered. From the graphical representation it is noted that AQM-RED-CPTQ scheme has resultsed the lesser Goodput when specially 2 and 100 nodes are considered in a system.

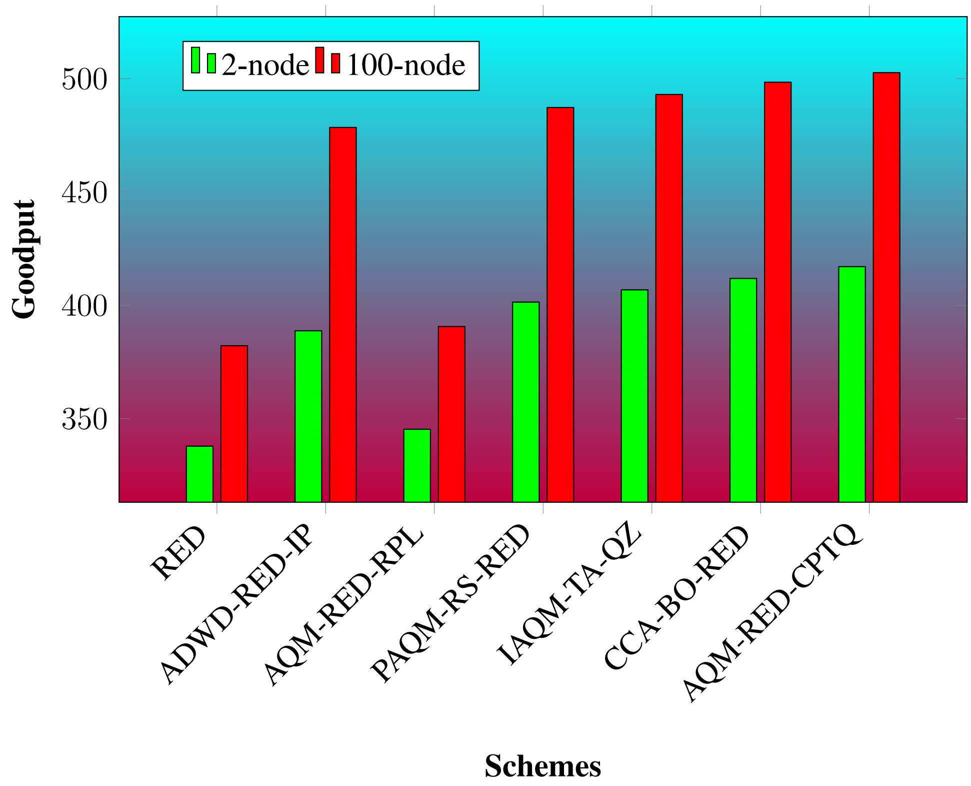

Figure 10.4: *Goodput when only 2 and 100 number of nodes are considered*

Table 10.5: *Comparison with existing scheme*

Algorithms	Packets received	Packets sent	Packets dropped	Packet Loss Rate	Throughput
RED	8487	8018.643	463.4286	0.0612	1.170581
ERED	8370.143	8155.071	206.3571	0.0235	1.192354
SRED	8521.571	8149.929	324.7143	0.0352	1.19231
REM	8459.643	8144.214	304.4268	0.0356	1.190913
BLUE	8358.357	8055.5	295.2857	0.0362	1.176324
LDC	8448.357	8068.214	371.8571	0.0455	1.179368
FRED	8631.714	7280.5	1350.286	0.1755	1.054913
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
CCA-BO-RED	8810	8719.320	190.320	0.0217	1.180437
AQM-RED-CPTQ	8900	8814.764	185.236	0.0210	1.180669

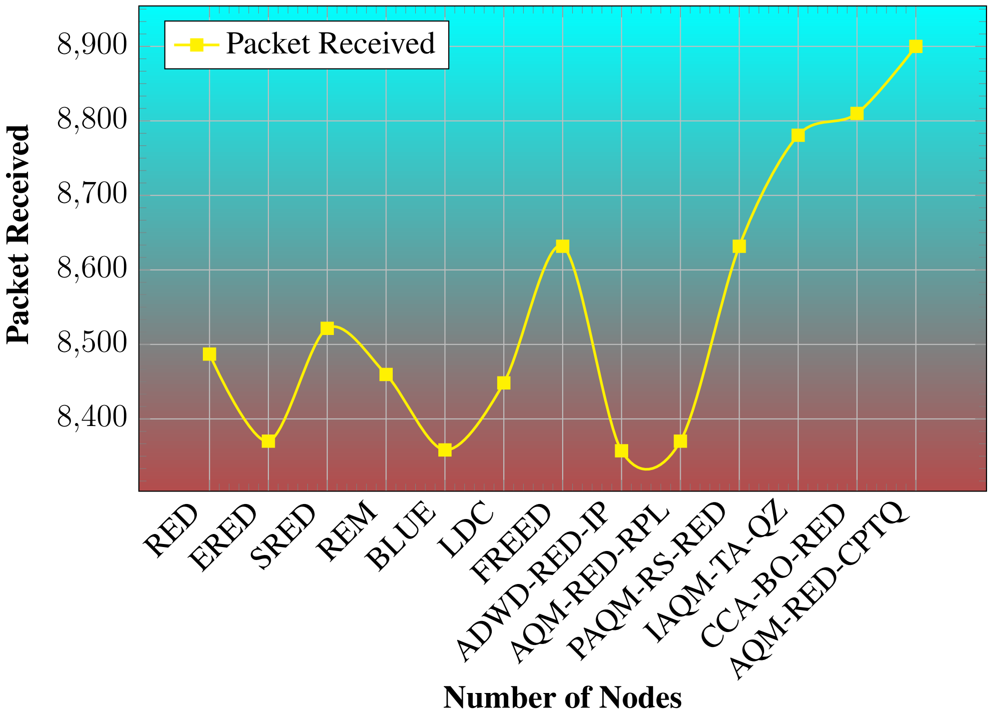

Figure 10.5: *Comparison graph w.r.t Packet Received*

Simulations demonstrate that AQM-RED-CPTQ produces a higher and more reliable performance and acts good because of the lowest packet drops than existing successful queue management algorithms. The detail results are tabulated in Table 10.5. This investigation has demonstrated the active queue management algorithms that use average queue size and different probabilistic value. Most of the proposed models achieve high performances with respect to packet dropped, packet loss rate and throughput. Figure 10.7, 10.8, 10.5, and 10.9 depict the graphical representation of packet received and packet sent, packet dropped, packet loss rate and throughput respectively. Here, we have compared our proposed schemes with the some of the popular existing schemes like - RED, ERED, SRED, REM, BLUE, LDC, and FREED. Fig. 10.7 depicts that the number of packet drop count is less than all the existing schemes.

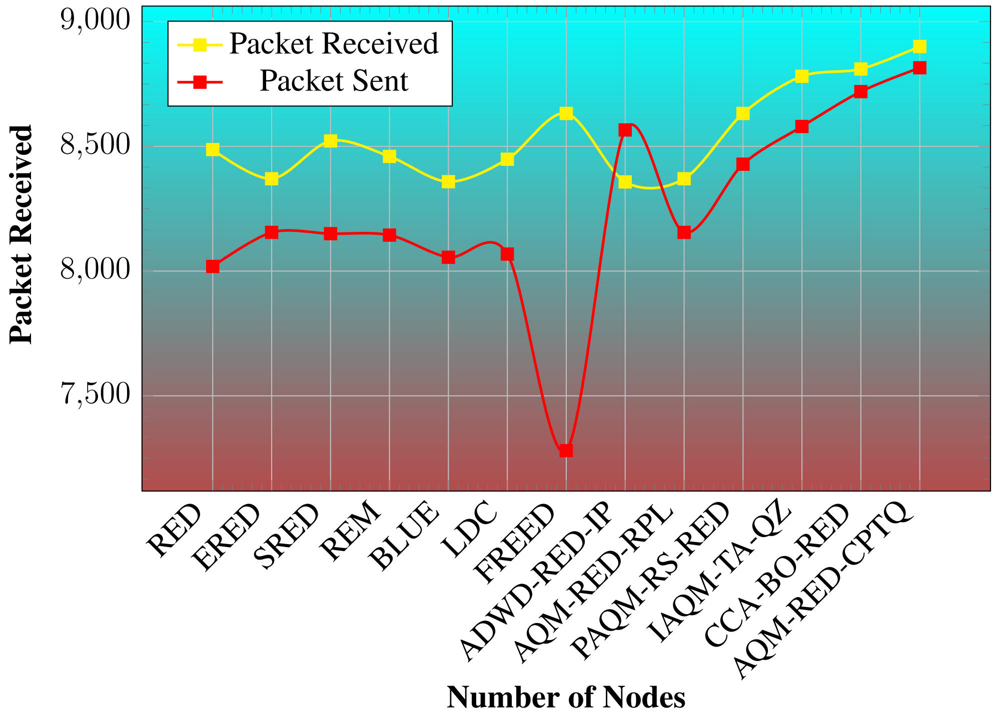

Figure 10.6: *Comparison graph w.r.t Packet Received and Packet Sent*

10.2 Limitations

Some limitations of the proposed scheme are as follows:

Multiple attacks target the nodes in MANET and fail to achieve the right balance between data security and congestion rating. In order to resolve this, there is a need for a safe mechanism to provide data packet integrity and prevent further congestion.

The proposed models produces better results in view of more quality such as less delay, more packet delivery ratio and increased throughput. But the results may vary in real time implementation due to physical and environmental constraints.

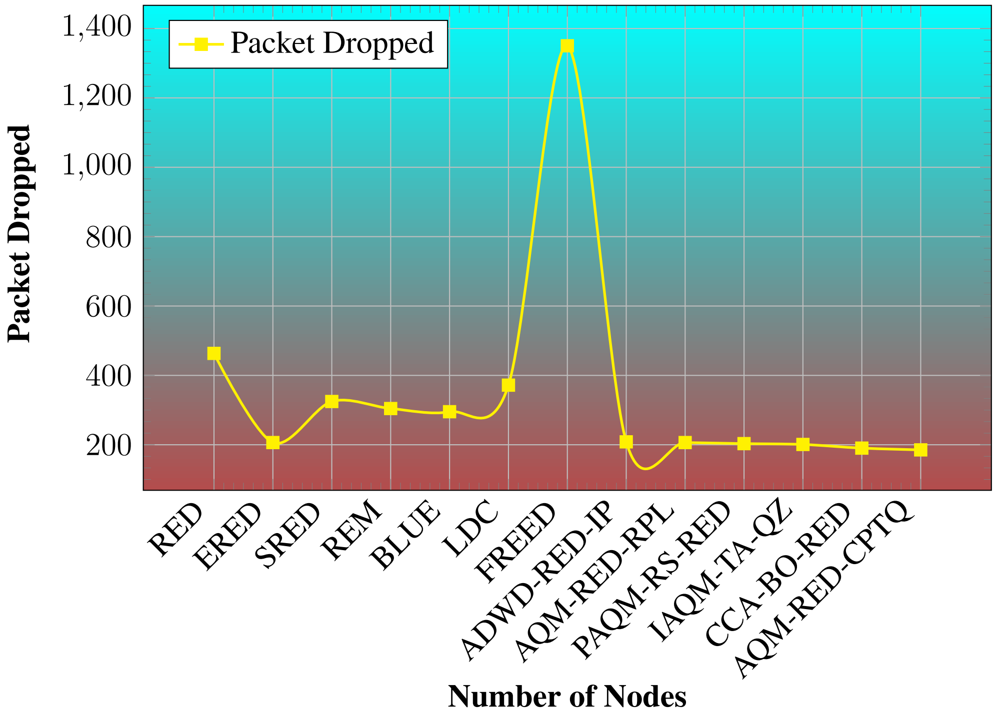

Figure 10.7: *Comparison graph w.r.t Packet Dropped*

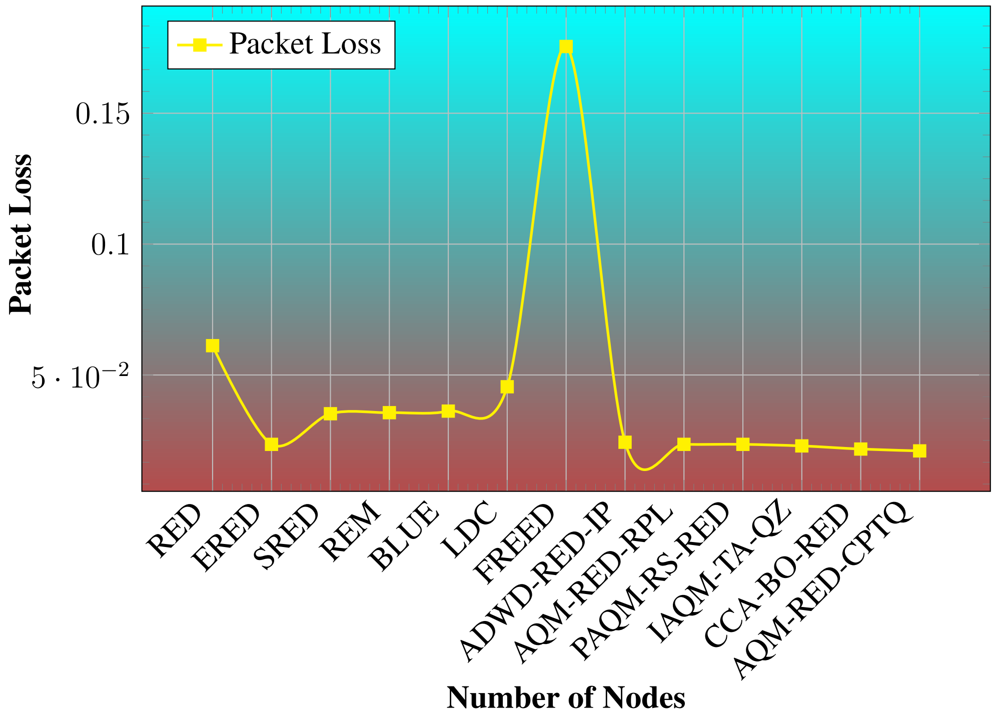

Figure 10.8: *Comparison graph w.r.t Packet Loss Rate*

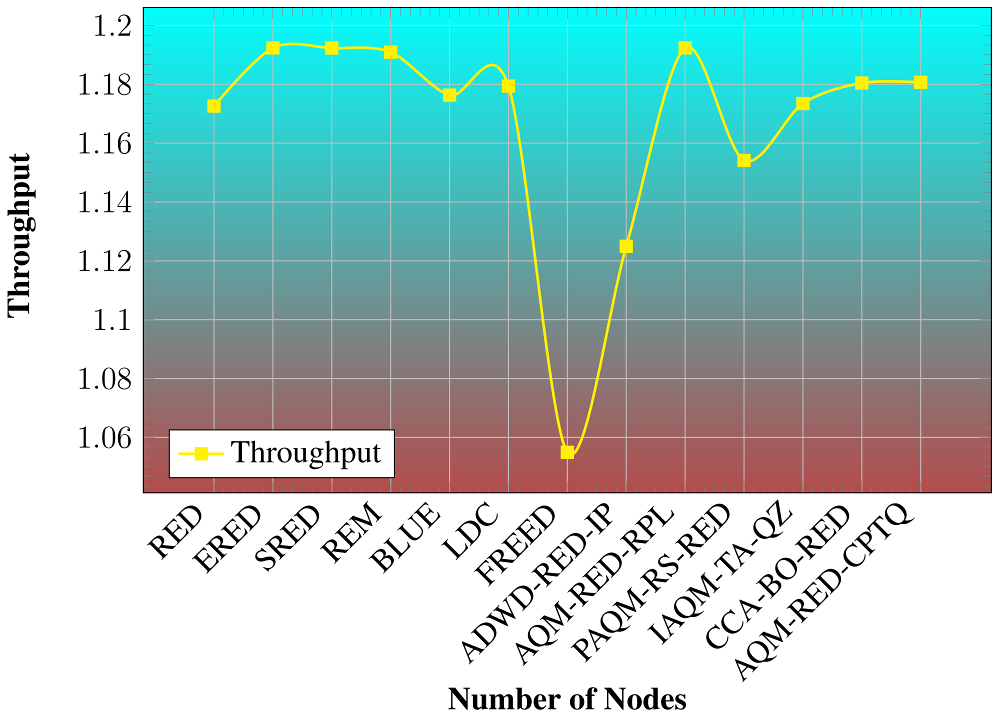

Figure 10.9: *Comparison graph w.r.t Throughput*

10.3 Future Scope

In this section, the specific direction for future research has been mentioned. Queue-based algorithms are difficult to configure. Load-based algorithms reduce delay, but sometimes exhibit low throughput. A configurable combination that takes into consideration input rate, drain rate and queuing delay works well. Further studies are required for LDC with ECN, parameter values of LDC, and the effect of variable output rate in multiple queues.

The level of security compliance depends on the actions of the nodes. In the future, it will be possible to incorporate sound safe connection control systems into current methods.