PERFORMANCE ANALYSIS OF DIFFERENT ROUTING PROTOCOLS IN AN AD-HOC ENVIRONMENT USING SCTP

A thesis submitted in partial fulfillment of the requirements for the award of the degree of

B. Tech

In

Computer Science and Engineering

By

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BONAFIDE CERTIFICATE

This is to certify that the project titled **Performance analysis of different routing protocols in an ad-hoc environment using SCTP** is a bonafide record of work done by

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in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering** of the **National Institute of Technology Puducherry**, during the year 2013-14.

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ABSTRACT

Ad hoc networks are decentralized wireless networks without infrastructure, where nodes communicate over wireless channels. As ad hoc networks lack infrastructure such as routers or access points, each node participates in routing by forwarding data to other nodes dynamically, depending on the network connectivity at that point of time. For this reason, the ad hoc routing protocols are different from the conventional routing protocols used in networks with infrastructure. The nodes, in an ad hoc network, can move freely and are allowed to join and leave the network at any point of time. This results in problems for the upper layers when it unexpectedly exits lower layer at the protocol stack. SCTP is a message oriented and reliable transport layer protocol which has been proven to be a reliable alternative to TCP in the ad hoc environment because of its multi homing and multi streaming features. In our project we have compared multiple ad hoc routing protocols with SCTP as the transport layer protocol. Performance parameters such as packet delivery ratio, throughput and end-to-end delay have been taken into account and analyzed for the various routing protocols in both single homing and multi homing conditions. The results after the analysis have been shown.

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LIST OF ABBREVIATIONS

SCTP: Stream Control Transmission Protocol

TCP: Transmission Control Protocol

UDP: User Datagram Protocol

AOMDV: Ad hoc On Demand Multipath Distance Vector Protocol

AODV: Ad hoc On Demand Distance Vector Protocol

DSR: Dynamic Source Routing

DSDV: Destination Sequenced Distance Vector Protocol

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EXISTING WORK

Some researchers have paid attention to how SCTP supports ad hoc scenarios. In [2] a brief comparison between the performances of TCP vs. SCTP within ad hoc networks was presented. The analysis was performed through simulations with reference to nodes mobility. For analysis they used the simulator NS2, while the scenario used was constituted by 46 mobile nodes inside an area of 1000x300 m2 with CBR traffic. The authors shown the faster decreasing of the SCTP performances, in term of goodput, in comparison with TCP, they in fact, from their point of view, assess that the TCP outperfoms SCTP. Besides increasing the mobility, the number of retransmissions goes up, and the TCP introduce better performances. However the provided analysis is poor and the dissertation is too short to explain the issue well. In [3] the authors have evaluated performances of SCTP with two different routing protocols: AODV and DSR. For the analysis simulator NS2 was employed. The scenario was dynamic, the nodes had a maximum speed of 20 m/s inside an area of 600x600 m2, while simulation time was of 200 s for each proof. They assert that, independently from the routing protocol, the percentage of delivered messages is sensitively less in TCP respect to SCTP. This one succeeds having a elevated throughput. The authors did not consider proactive routing protocols. In [4] SCTP was investigated with reference to the effect of congestion on the throughput. The simulative study was performed on static scenarios constituted by four hosts along a straight line. Under these conditions the authors analyzed the throughput varying the dimension of the receiver's window and also varying the number of hops. They have shown that the throughput decreases with the increase of the number of hops and that a larger receiver's window does not guarantee an increase in the overall throughput. Then, they have proposed a modified SCTP to improve the throughput.

INTRODUCTION

Wireless ad hoc networks are characterized by unique properties and challenging environments which limit the utilization of traditional networking techniques. Wireless links are highly error prone and they can break frequently because of node mobility, interference and channel fading. It implies that the end-to-end paths between the source and sink frequently change. It is very hard to maintain end-to-end routing because of the dynamic topology of the system. As a consequence of its unique characteristics, the wireless ad hoc environment has its own set of routing protocols under the general reactive, proactive and hybrid categories such as AODV, AOMDV, DSDV, DSR, TORA, etc.

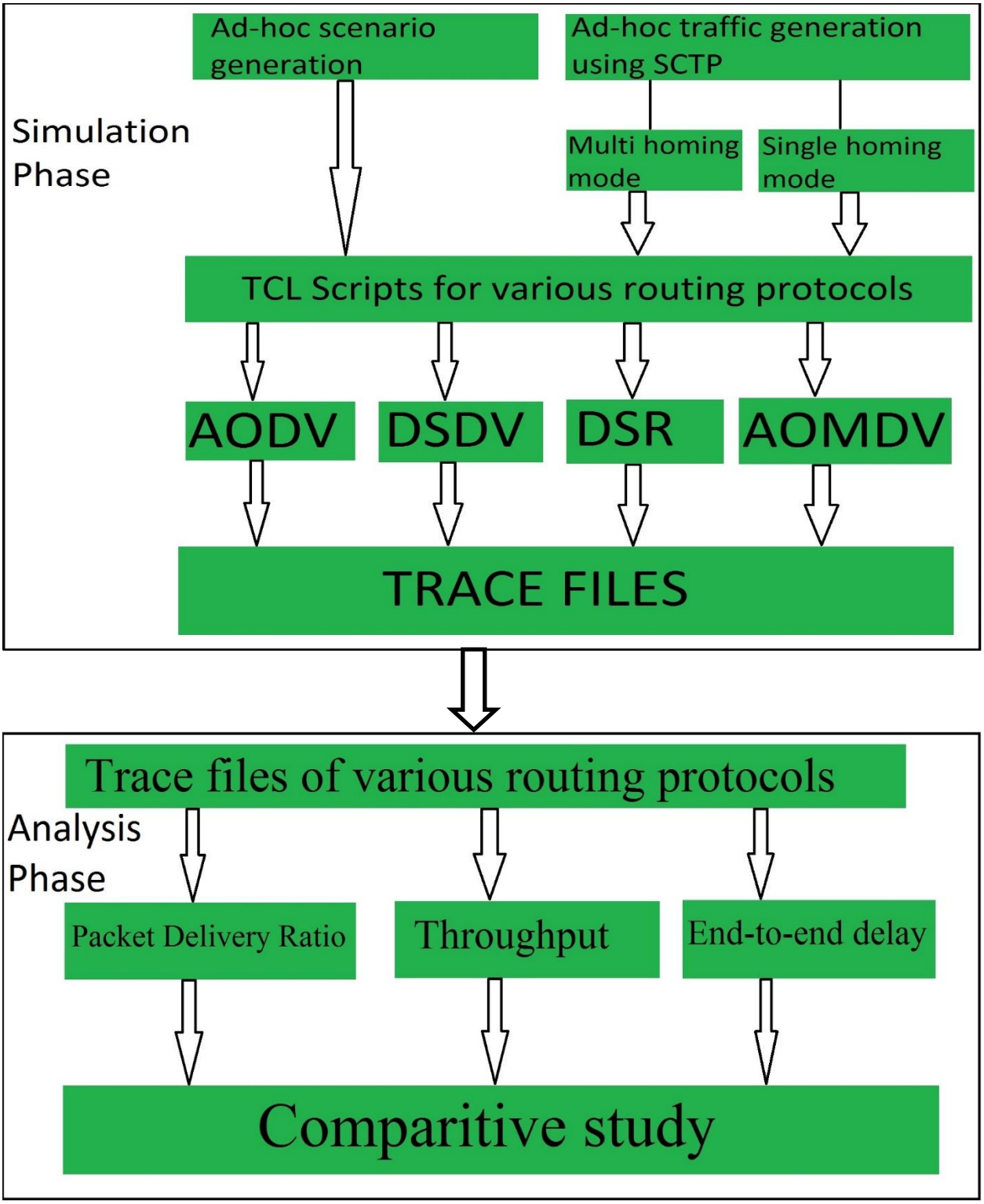
SCTP or Stream Control Transmission Protocol is message oriented and reliable transport layer protocol. It serves in similar roles as the popular TCP and UDP protocols. It is message oriented i.e. connectionless like UDP but ensures reliable, in-sequence transmission of messages like TCP, with congestion control. SCTP has certain notable features and characteristics which distinguish it from these popular protocols and make it unique. Among these features is the support for multi homing. In the multi homing mode, SCTP allows one or both end points of a connection to have more than one IP address, enabling transparent fail over between redundant network paths. The delivery is message oriented even within independent streams. This clearly eliminates most of the head-of-line blocking unlike the TCP byte stream delivery. Moreover the validation and acknowledgement mechanisms provide notifications of duplicate or missing data chunks.

In our project we have implemented SCTP in the ad hoc environment using the network simulator NS2. Routing protocols such as AODV, DSDV, DSR and AOMDV have been implemented alongside SCTP. The ad hoc environment has been implemented in a 500X500 square meters area in each case.

Performance parameters such as packet delivery ratio, throughput and end-to-end delay have been evaluated from the trace files obtained from the simulations of each case. The variation of each performance parameter has been recorded against that of the number of nodes and that of pause-time i.e. mobility of the nodes. Observations have been tabulated and presented as graphs and possible conclusions have been underlined wherever seen appropriate.

PROPOSED WORK

BLOCK DIAGRAM



Ad hoc scenario generation
The dimensions of the network such as area, the number of nodes and their mobility

Ad hoc traffic generation
The number of nodes, maximum number of active connections in the network, mode of SCTP i.e. whether single homing or multi homing

Tcl scripts
Node configuration, takes the scenario and traffic generation files as input

Trace Files
The recorded simulated results

Packet Delivery Ratio
Ratio of number of successfully delivered packets to the total number of packets transmitted

End-to-end Delay
Time taken for the packet to be transmitted across the network from source to destination

Throughput
Rate of successful message delivery over a communication channel with respect to time

ANALYSIS

PACKET DELIVERY RATIO

Comparison of packet delivery ratio of a network using AODV for single homing and multi homing with variation in number of nodes

	AODV	
No. of nodes	Single Homing	Multi Homing
10	759.496	744.026
20	903.227	1380.51
30	934.888	1109.15
40	1282	1378.35
50	1387.5	1219.91
60	1121.96	1073.55
70	1441.68	1331.46
80	1331.97	1248.42
90	842.461	1026.02
100	1266.46	834.552

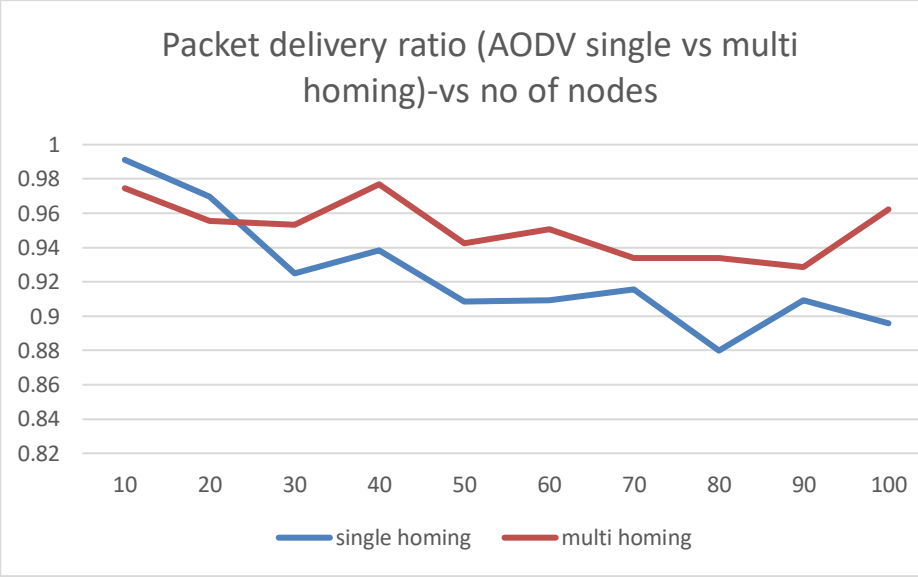


Figure 1

In figure 1, packet delivery ratio, comparison between single and multihoming for ad hoc networks using SCTP has been done and it was seen that with the increase in network traffic rate, multi homing has performed better than single homing for AODV.

Comparison of packet delivery ratio of a network using DSDV for single homing and multi homing with variation in number of nodes

	DSDV	
No. of nodes	Single Homing	Multi Homing
10	0.996648	0.979545
20	0.984449	0.981367
30	0.975374	0.974543
40	0.974153	0.972013
50	0.963856	0.981528
60	0.961743	0.964586
70	0.969633	0.971598
80	0.954517	0.966071
90	0.966118	0.966071
100	0.950178	0.95139

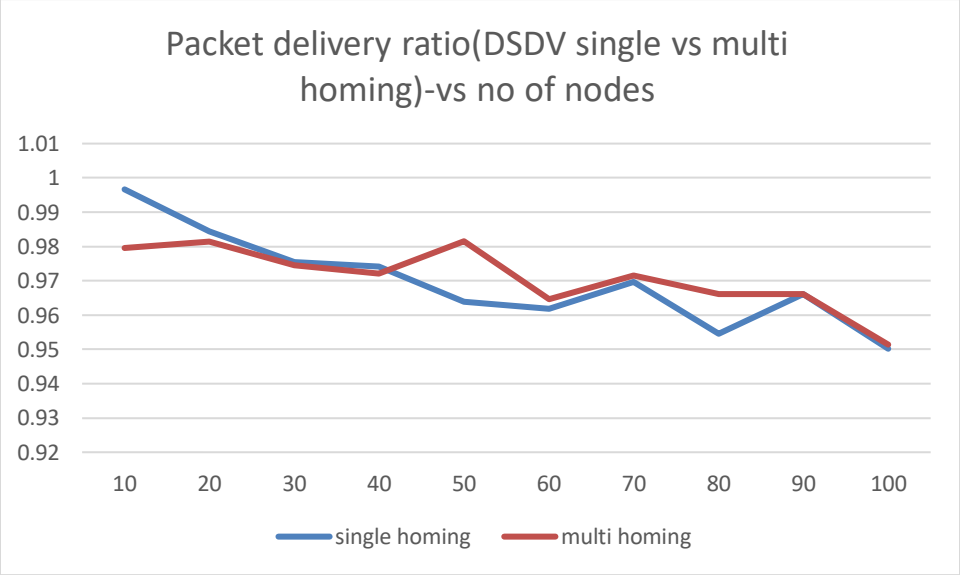


Figure 2

In figure 2, packet delivery ratio, comparison between single and multihoming for ad hoc networks using SCTP has been done and it has been seen that for DSDV, multi homing has performed better than its single homing counter part with increase in network traffic.

Comparison of packet delivery ratio of a network using AOMDV for single homing and multi homing with variation in number of nodes

	AOMDV	
No. of nodes	Single Homing	Multi Homing
10	0.99707	0.992507
20	0.98066	0.981081
30	0.975511	0.980949
40	0.962642	0.973866
50	0.968537	0.970242
60	0.956335	0.967971
70	0.959732	0.975173
80	0.950176	0.97246
90	0.952231	0.957734
100	0.92938	0.96912

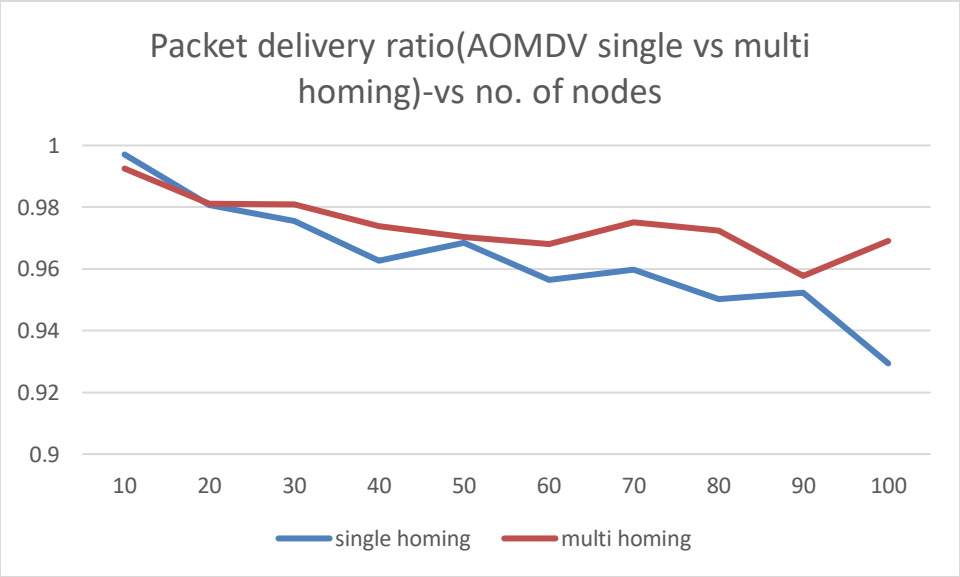


Figure 3

In figure 3, packet delivery ratio, comparison between single and multihoming for ad hoc networks using SCTP has been done, it has been seen that for AOMDV multi homing has performed better than its other counter part with increase in network traffic.

Comparison of packet delivery ratio of a network using AODV for single homing and multi homing with variation in pause time

	AODV	
Pause Time	Single Homing	Multi Homing
0	0.934233	0.951837
10	0.940289	0.947347
20	0.930079	0.95178
30	0.9359	0.952039
40	0.934336	0.951224
50	0.947678	0.957908
60	0.943568	0.945369
70	0.937414	0.948061
80	0.916632	0.945525
90	0.91967	0.949717
100	0.934688	0.961307

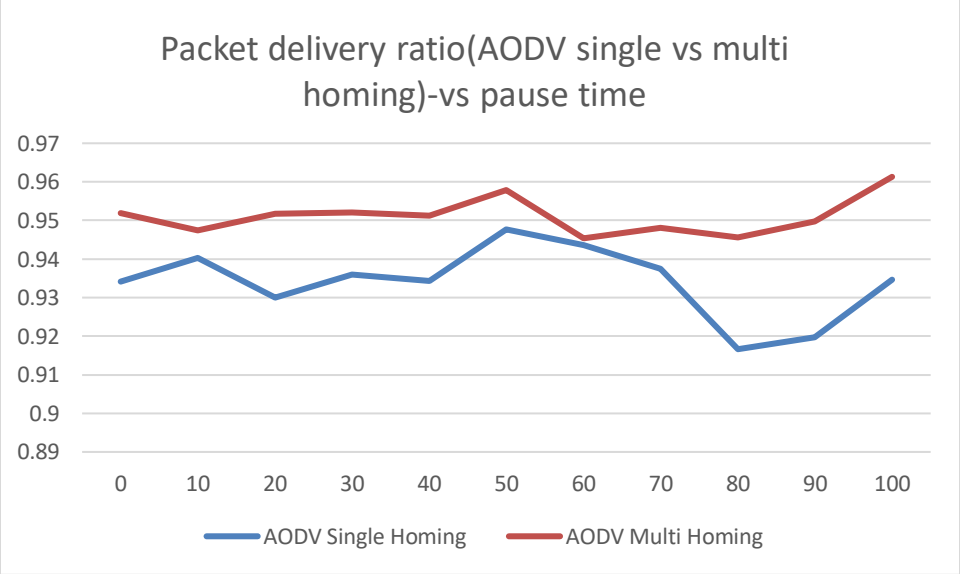


Figure 4

In figure 4, packet delivery ratio for a network using SCTP, pause time was increased and still it was seen that multi homing has performed well than single homing for AODV.

Comparison of packet delivery ratio of a network using DSDV for single homing and multi homing with variation in pause time

	DSDV	
Pause Time	Single Homing	Multi Homing
0	0.965062	0.978445
10	0.979898	0.97205
20	0.973257	0.972101
30	0.969558	0.971218
40	0.955334	0.977528
50	0.965929	0.971979
60	0.952233	0.955105
70	0.956013	0.965735
80	0.976071	0.984212
90	0.975839	0.977105
100	0.97104	0.973048

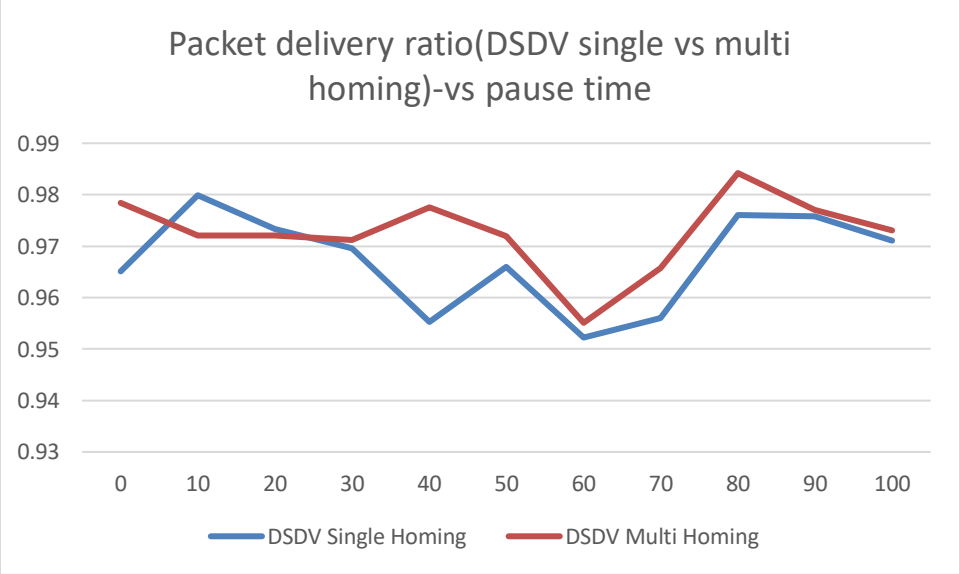


Figure 5

In figure 5,Packet Delivery Ratio of a network using SCTP, mobility among the nodes was increased and Multi homing has performed better than single homing for DSDV.

Comparison of packet delivery ratio of a network using AOMDV for single homing and multi homing with variation in pause time

	AOMDV	
Pause Time	Single Homing	Multi Homing
0	0.974284	0.968502
10	0.970708	0.97187
20	0.972503	0.963977
30	0.965119	0.967154
40	0.971322	0.979043
50	0.973654	0.975739
60	0.961858	0.971035
70	0.975559	0.976718
80	0.970667	0.974268
90	0.963545	0.971055
100	0.972072	0.979801

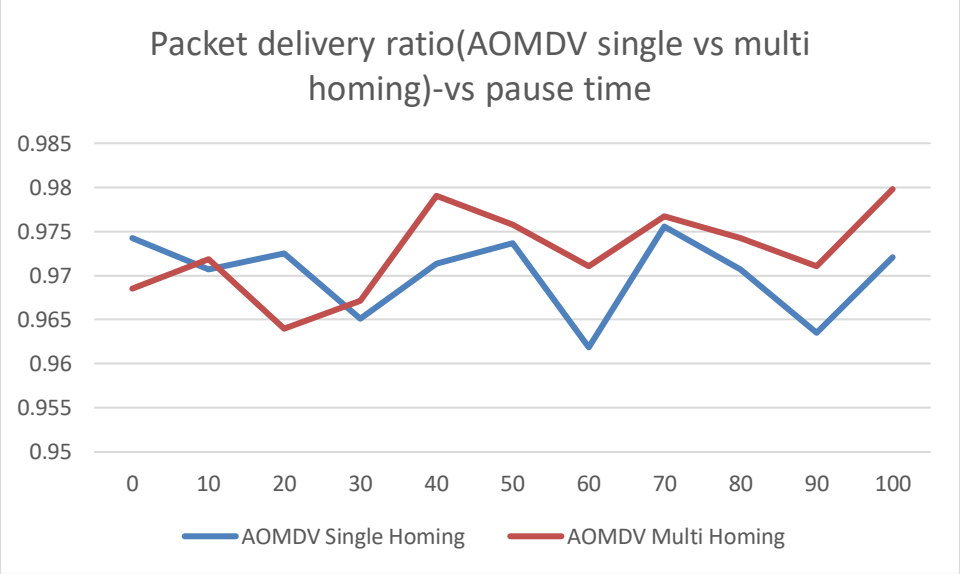


Figure 6

In figure 6, packet delivery ratio for a network using SCTP, multi homing has performed better than single homing for AOMDV with increased mobility among nodes.

THROUGHPUT(in kbps)

Comparison of throughput of a network using AODV for single homing and multi homing with variation in number of nodes

	AODV	
No. of nodes	Single Homing	Multi Homing
10	530.394	330.94
20	205.443	198.84
30	124.532	162.935
40	116	162.504
50	151.523	147.014
60	161.375	209.702
70	182.748	172.661
80	103.101	162.484
90	137.629	300.989
100	107.029	146.388

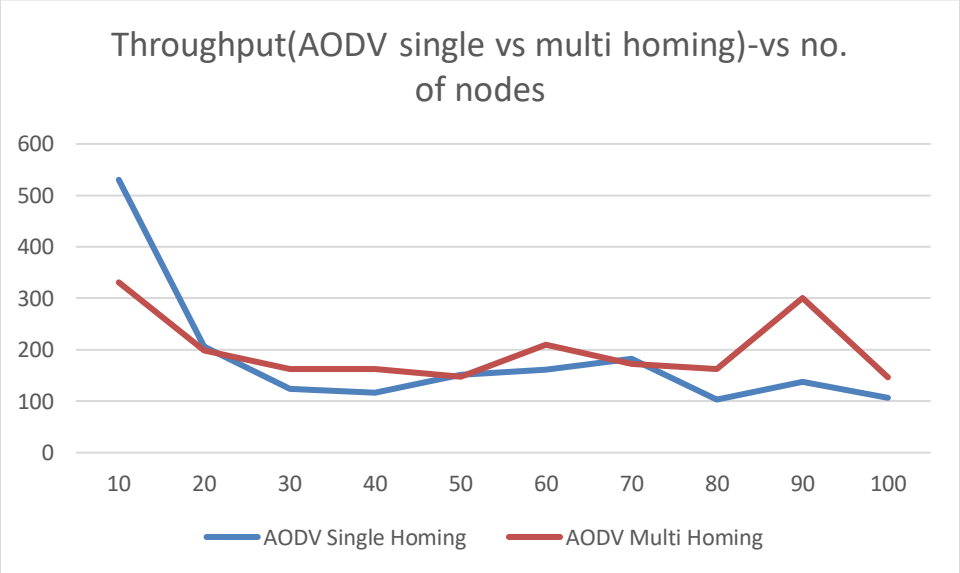


Figure 7

In the figure 7, throughput of a network using SCTP, multi homing has performed better than single homing for AODV with increase in network traffic.

Comparison of throughput of a network using DSDV for single homing and multi homing with variation in no. of nodes

	DSDV	
No. of nodes	Single Homing	Multi Homing
10	330.01	318.184
20	342.547	364.898
30	385.986	323.516
40	117.06	141.091
50	141.125	190.718
60	222.282	208.595
70	133.672	163.642
80	177.406	170.439
90	138.23	112.33
100	174.984	113.979

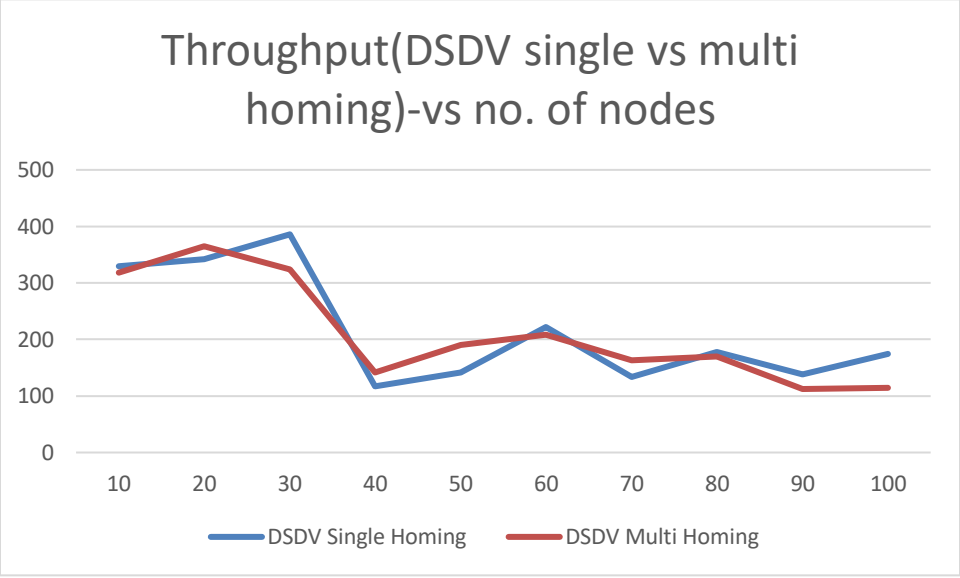


Figure 8

In figure 8, throughput of a network using SCTP, multi homing has performed better than single homing for DSDV with increase in network traffic

Comparison of throughput of a network using AOMDV for single homing and multi homing with variation in no. of nodes

	AOMDV	
No. of nodes	Single Homing	Multi Homing
10	232.038	490.229
20	215.255	204.968
30	271.714	236.403
40	177.415	172.113
50	189.285	211.986
60	189.353	134.074
70	179.386	157.996
80	153.442	139.221
90	172.607	141.537
100	147.343	114.216

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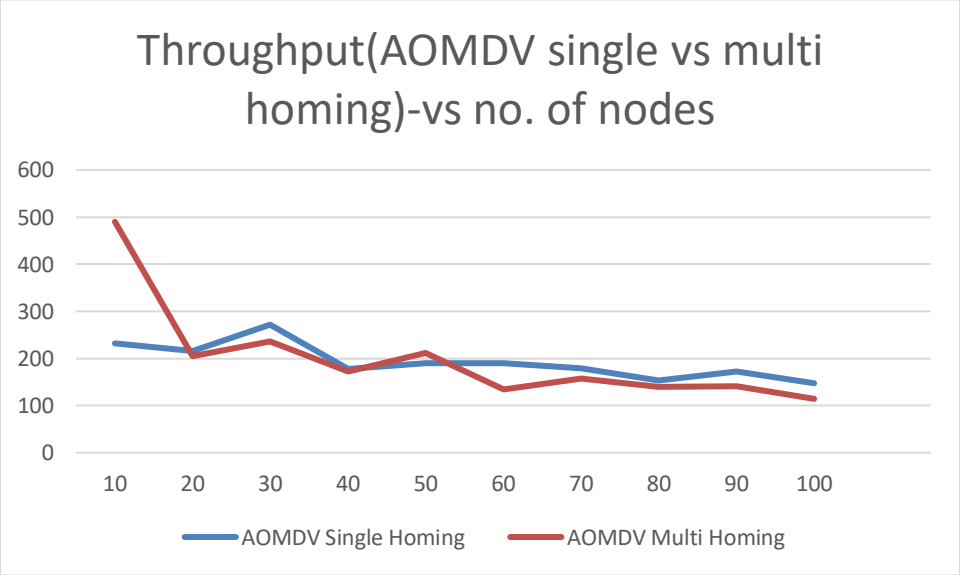

Figure 9

In figure 9, throughput of a network, it can be seen that for AOMDV,single homing has performed well than multihoming with increase in network traffic.

Comparison of throughput of a network using AODV for single homing and multi homing with variation in pause time

	AODV	
Pause Time	Single Homing	Multi Homing
0	172.343	223.28
10	196.332	234.925
20	192.974	269.784
30	203.711	191.272
40	190.502	227.986
50	208.534	199.501
60	271.638	197.201
70	236.212	219.987
80	200.247	205.13
90	238.646	226.791
100	195.473	215.381

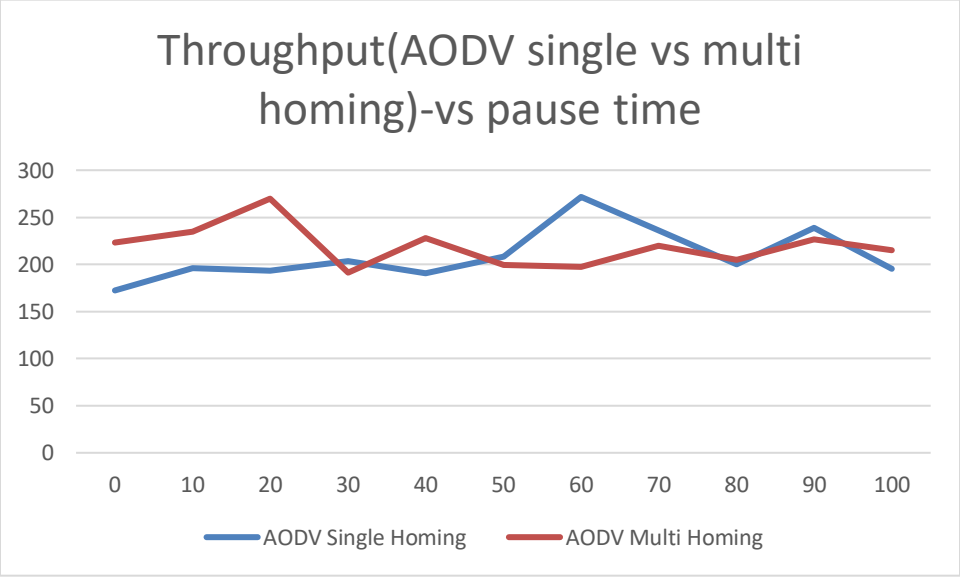

Figure 10

In figure 8, throughput of a network using SCTP, it can be seen that for AODV, single homing has performed slightly better than multihoming with increase in mobility among nodes.

Comparison of throughput of a network using DSDV for single homing and multi homing with variation in pause time

	DSDV	
Pause Time	Single Homing	Multi Homing
0	216.06	131.588
10	282.383	328.474
20	248.494	252.566
30	248.273	126.325
40	316.781	150.218
50	252.423	259.956
60	236.927	217.804
70	254.449	150.338
80	232.74	164.048
90	215.935	209.521
100	230.248	121.582

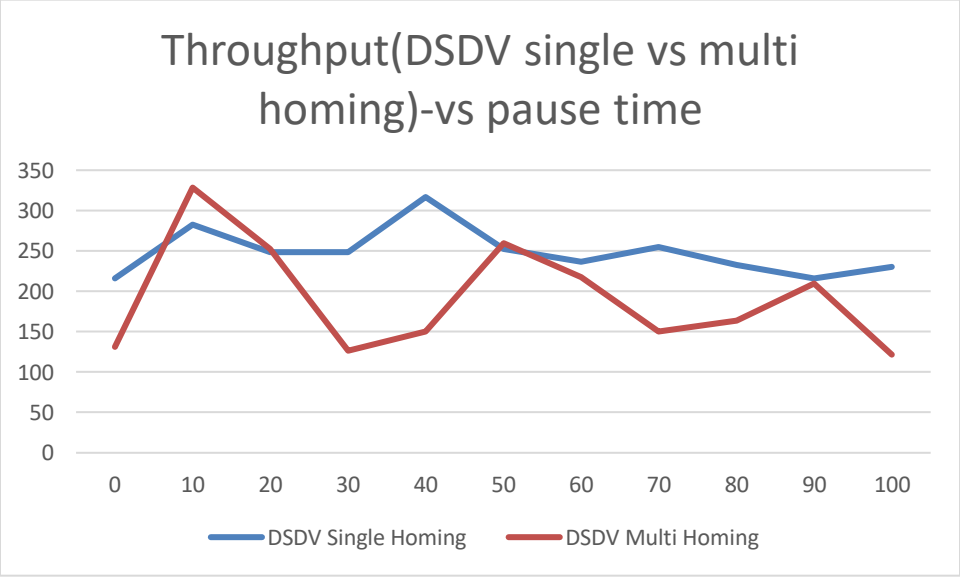

Figure 11

In figure 11, throughput of a network, it can be seen that for AOMDV single homing has performed well than multihoming with increased mobility among nodes.

Comparison of throughput of a network using AOMDV for single homing and multi homing with variation in pause time

	AOMDV	
Pause Time	Single Homing	Multi Homing
0	141.271	165.273
10	156.88	170.028
20	196.734	165.3
30	146.024	142.392
40	165.17	194.227
50	209.723	146.66
60	156.141	206.007
70	210.076	190.044
80	181.703	191.11
90	197.892	124.081
100	191.007	132.275

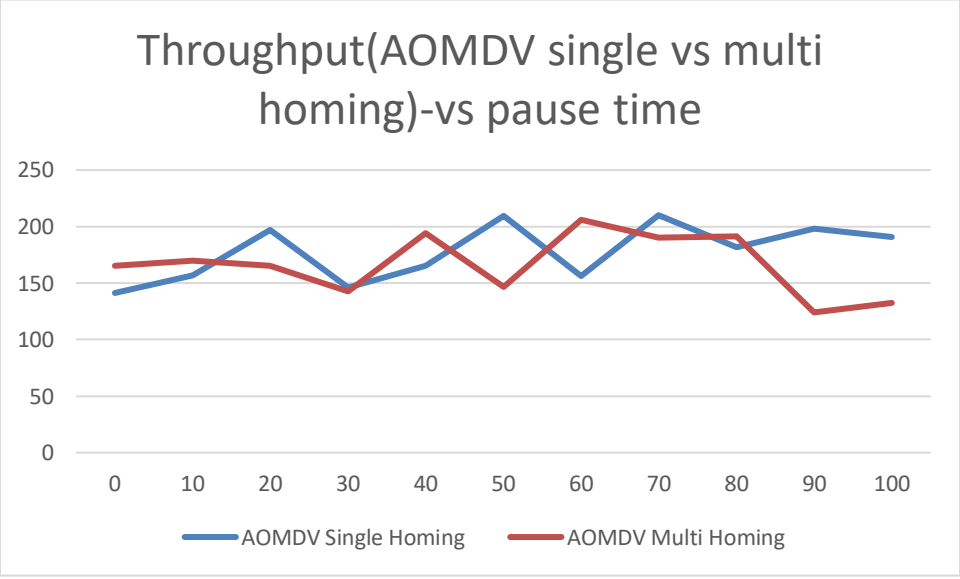

Figure 12

In figure 12, throughput of a network using SCTP, it can be seen that for AOMDV, single homing has performed well than multihoming with increase in mobility among nodes.

END-TO-END DELAY(in ms)

Comparison of end-to-end delay of a network using AODV for single homing and multi homing with variation in number of nodes

	AODV	
No. of nodes	Single Homing	Multi Homing
10	759.496	744.026
20	903.227	1380.51
30	934.888	1109.15
40	1282	1378.35
50	1387.5	1219.91
60	1121.96	1073.55
70	1441.68	1331.46
80	1331.97	1248.42
90	842.461	1026.02
100	1266.46	834.552

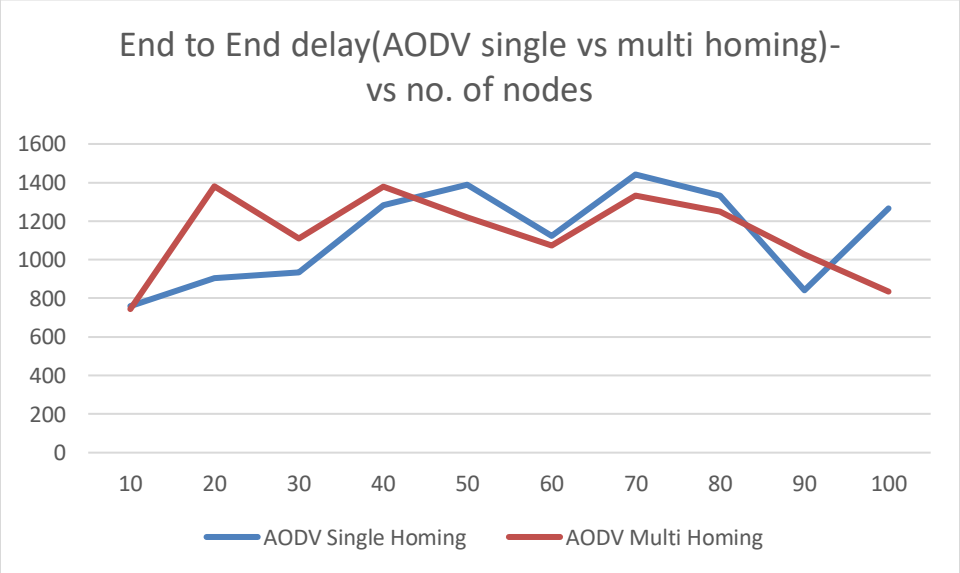

Figure 13

In figure 13, end to end delay calculation of a network using SCTP, it can be seen that for AODV multi homing has performed better than single homing with increase in network traffic.

Comparison of end-to-end delay of a network using DSDV for single homing and multi homing with variation in number of nodes

	DSDV	
No. of nodes	Single Homing	Multi Homing
10	736.737	579.034
20	966.959	665.224
30	813.042	756.851
40	819.547	1063.16
50	971.27	1098.95
60	700.047	761.025
70	990.298	874.036
80	988.641	835.596
90	1144.92	1004.51
100	1185.54	993.866

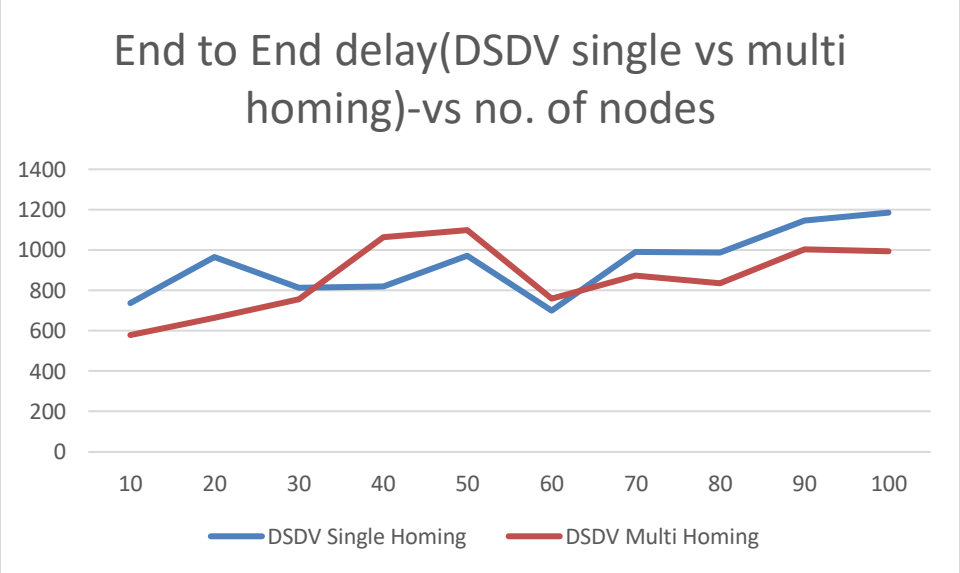

Figure 14

In figure 14, end to end delay calculation of a network using SCTP, it can be seen that for DSDV, multi homing has performed better than single homing with increased network traffic.

Comparison of end-to-end delay of a network using AOMDV for single homing and multi homing with variation in number of nodes

	AOMDV	
No. of nodes	Single Homing	Multi Homing
10	772.418	836.119
20	1029.3	1069.48
30	907.473	1193.17
40	1350.49	1496.63
50	1695.88	1391.84
60	1689.75	1634.16
70	1405.61	1538.9
80	1567.91	1247.59
90	1455.1	1481.29
100	1896.73	1776.28

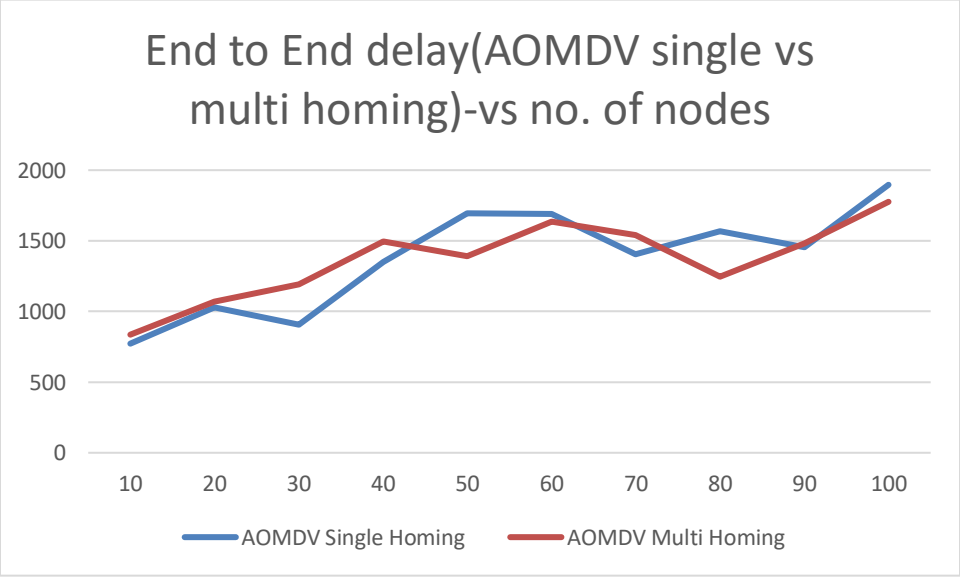

Figure 15

In figure 15, end to end delay calculation of a network using SCTP, it can be seen that for AOMDV multi homing has performed better than single homing with increased network traffic rate.

Comparison of end-to-end delay of a network using AODV for single homing and multi homing with variation in pause time

	AODV	
Pause Time	Single Homing	Multi Homing
0	1366.71	1005.1
10	1349.02	1183.93
20	1369.35	986.237
30	1079	1146.31
40	1265.04	1178.83
50	1311.24	1332.99
60	1888.6	1819.11
70	1903.94	1539.36
80	1300.09	1285.28
90	1699.7	1668.07
100	1859.54	1636.25

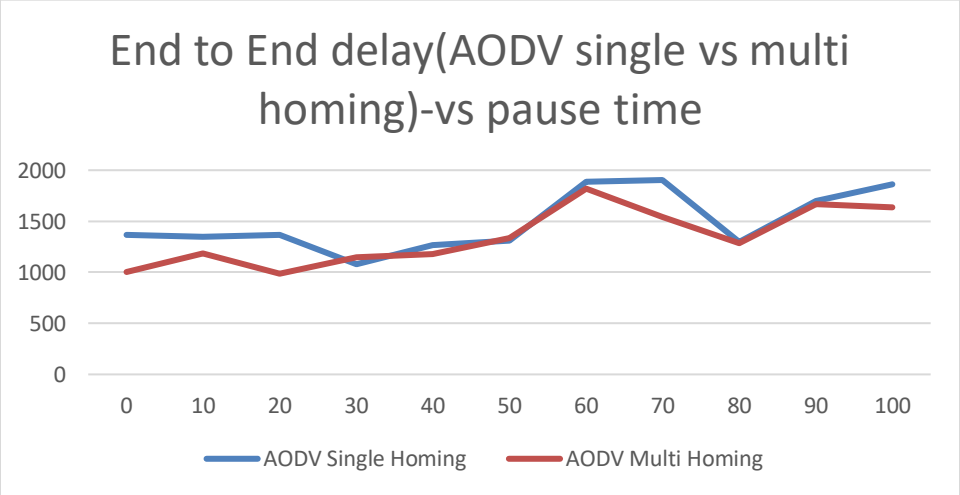

Figure 16

In figure 16, end to end delay calculation of a network using SCTP, it can be seen that for AODV multi homing has performed better than single homing with increase in mobility among the nodes.

Comparison of end-to-end delay of a network using DSDV for single homing and multi homing with variation in pause time

	DSDV	
Pause Time	Single Homing	Multi Homing
0	1222.85	1140.3
10	1032.74	903.011
20	892.139	926.831
30	1049.64	1261.26
40	1461.93	1061.93
50	1790.77	1273.18
60	1741.56	1214.5
70	1500.25	1579.86
80	1814.58	1694.87
90	1576.95	1420.74
100	1786.15	1548.8

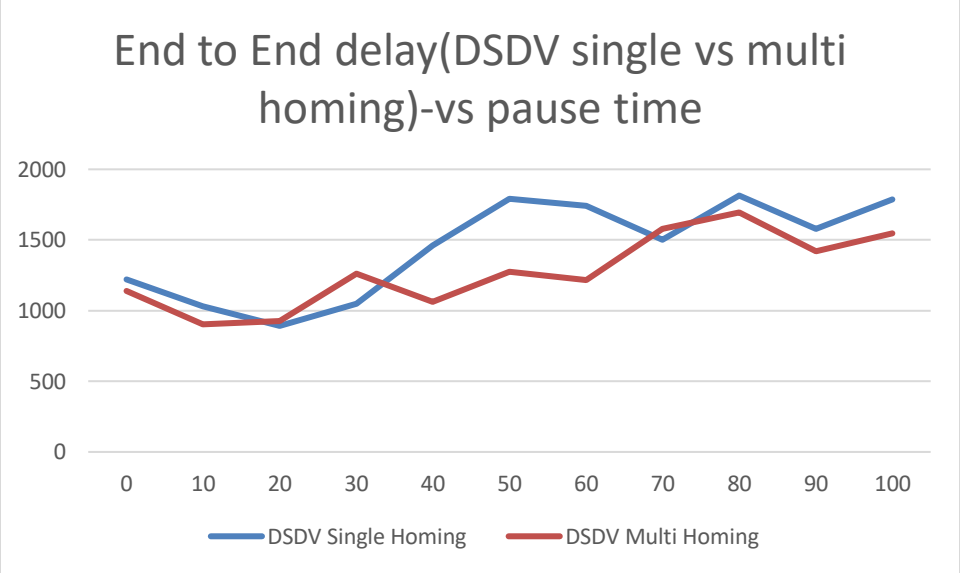

Figure 17

In figure 17, end to end delay calculation of a network using SCTP, it can be seen that for DSDV multi homing has performed better than single homing with increase in mobility among nodes.

Comparison of end-to-end delay of a network using AOMDV for single homing and multi homing with variation in number of nodes

	AOMDV	
Pause Time	Single Homing	Multi Homing
0	1434.24	1442.71
10	1517.51	1491.79
20	1560.96	1214.39
30	2156.37	1499.79
40	1955.44	1450.85
50	1429.96	1652.77
60	1579.72	1720.39
70	1725.32	1713.67
80	2319.71	1810.83
90	1772.85	2118.93
100	2280.32	1759.02

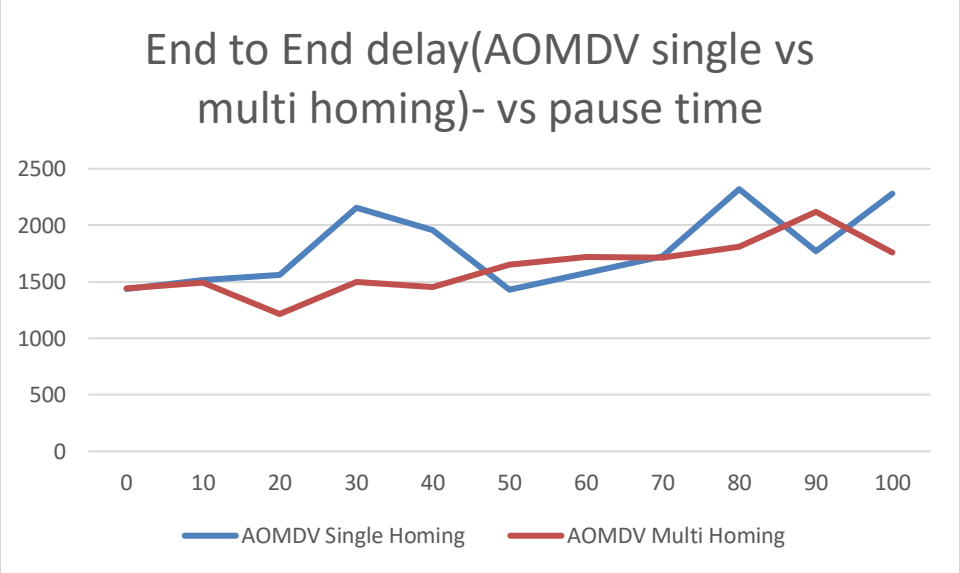

Figure 18

In figure 18, end to end delay calculation of a network using SCTP, it can be seen that for AOMDV multi homing has performed better than single homing with increase in mobility among nodes.

Comparison of packet delivery ratios of a network using different routing protocols with variations in number of nodes

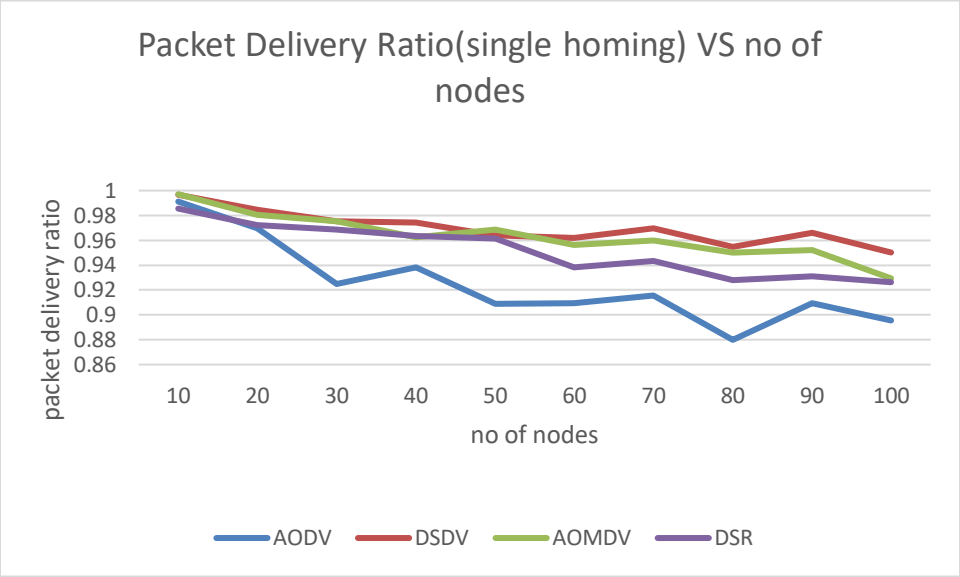

Figure 19

In figure 19, Packet Delivery ratio for different routing protocols using SCTP with its single homing feature, network traffic was increased by increasing the number of nodes and it can be seen that with increase in traffic rate, DSDV performs slightly better that the other routing protocols and among the reactive protocols DSR performs well than AODV and the multipath routing protocol AOMDV performs better than both DSR and AODV with higher traffic rate.

Comparison of packet delivery ratios of a network using different routing protocols with variations in number of nodes(multi homing)

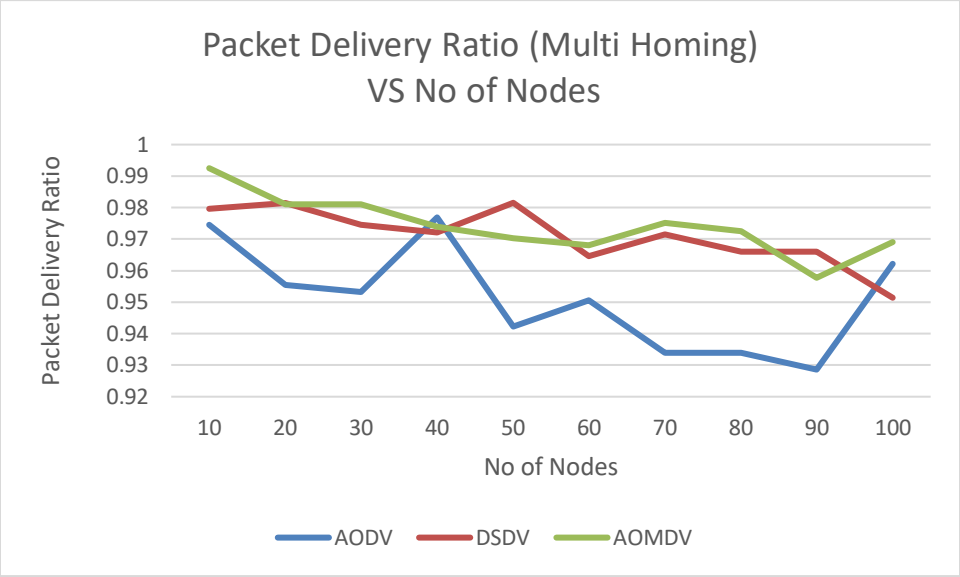

Figure 20

In figure 20, Packet Delivery Ratio of Different Routing Protocols using SCTP implemented with its multi homing feature, it can be seen that with increase in network traffic rate, AOMDV performs better than the other two routing protocols and it was also clearly visible that DSDV performs well than AODV with higher traffic rates.

Comparison of packet delivery ratios of a network using different routing protocols with variations in pause time

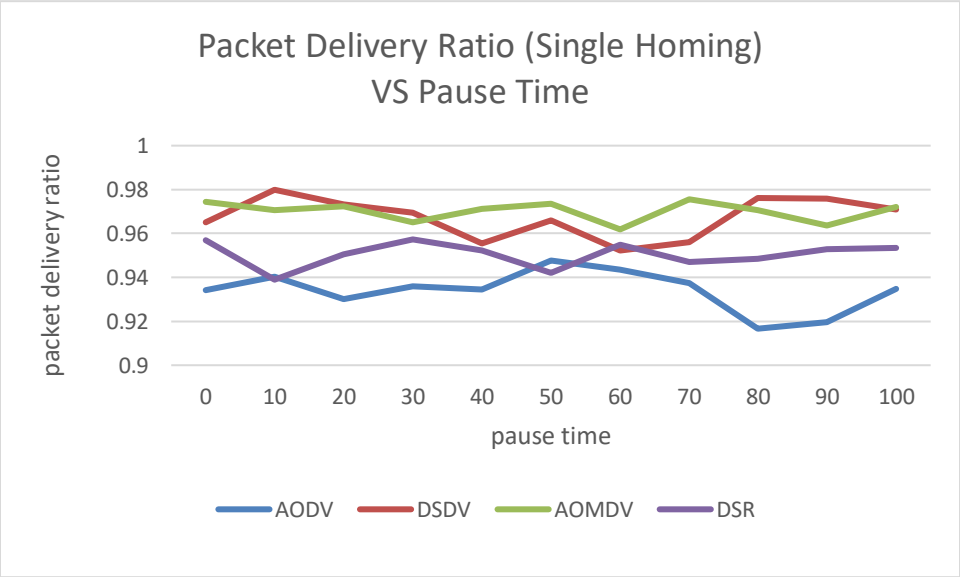

Figure 21

In figure 21, Packet Delivery Ratio for different routing protocols using SCTP, the mobility of the nodes were increased and it was seen that with the increase in the mobility among the nodes in the ad-hoc environment, AOMDV performs slightly well than the other routing protocols and among the reactive and proactive protocols, DSDV performed better than both DSR and AODV and among the reactive protocols DSR performs better than AODV.

Comparison of packet delivery ratios of a network using different routing protocols with variations in pause time(multi homing)

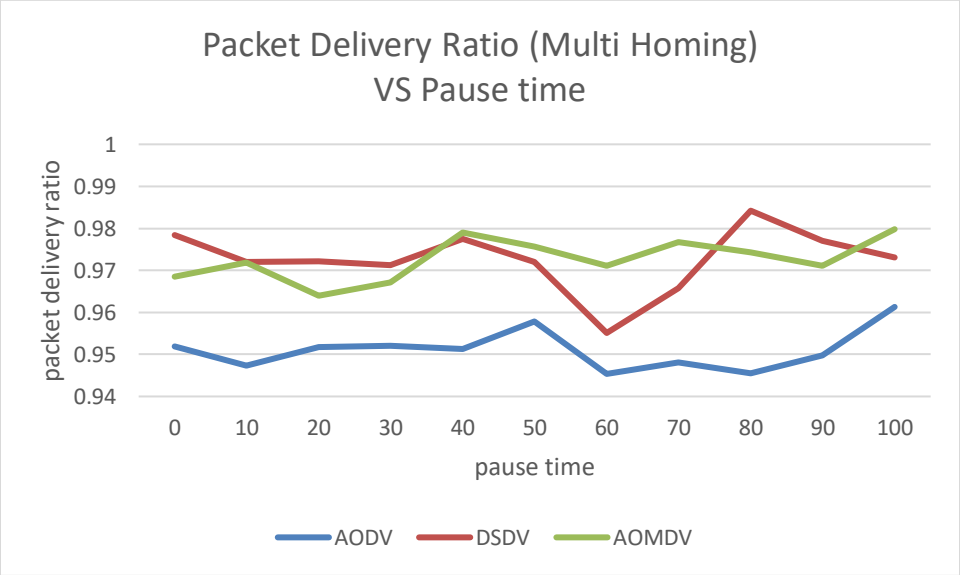

Figure 22

In figure 22, packet delivery ratio of different routing protocols for SCTP using its multi homing feature, it was seen that with increase in the mobility among the nodes, DSDV performs better than AOMDV and DSDV performed better than AODV.

Comparison of throughput of a network using different routing protocols with variations in number of nodes

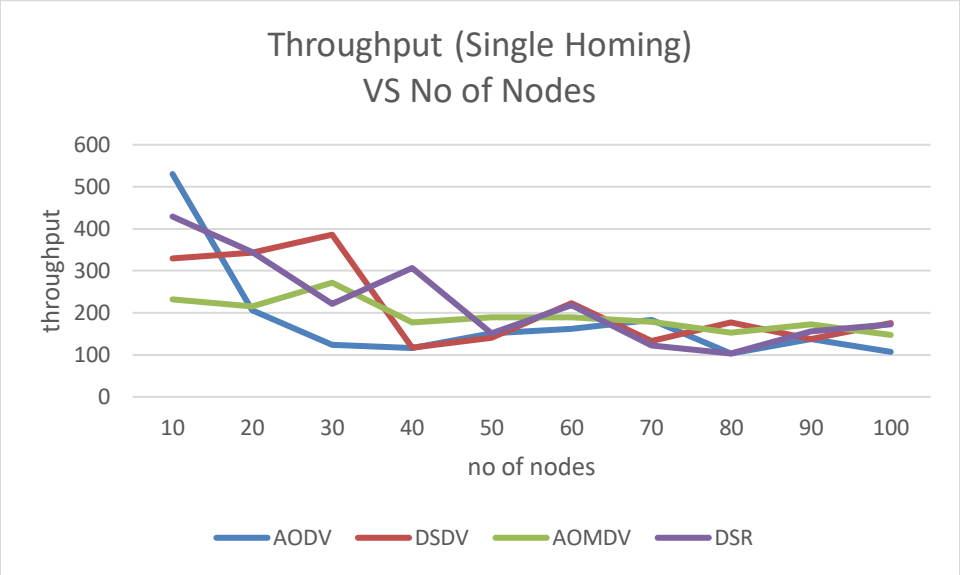

Figure 23

In the above Graph for Throughput of different routing protocols using SCTP, network traffic was increased AOMDV has slightly better than the other routing protocols. And DSDV has performed better than both DSR and AODV. Among DSR and AODV, DSR has performed better.

Comparison of throughput of a network using different routing protocols with variations in number of nodes(multi homing)

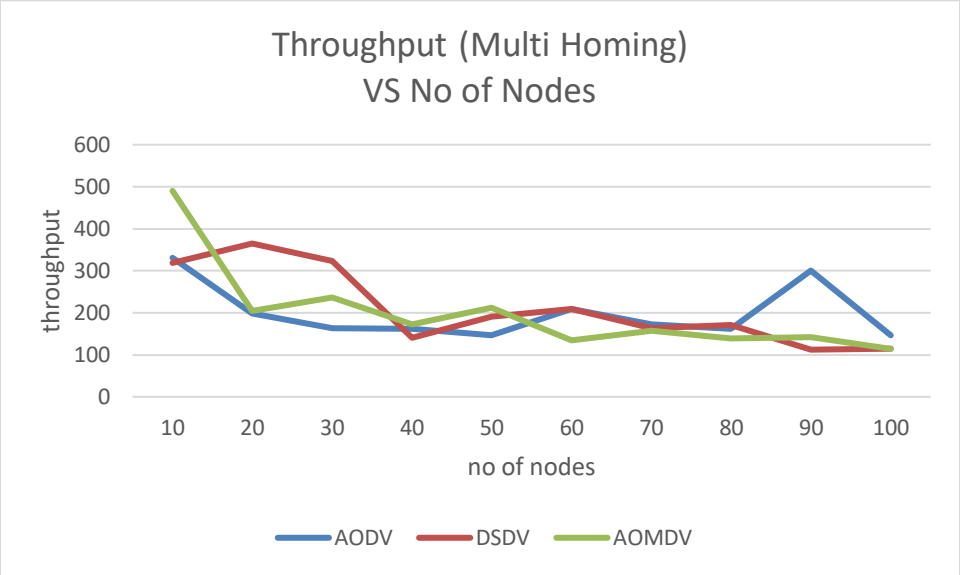

Figure 24

In figure 24, throughput for different routing protocols in an network using SCTP with its Multi Homing feature, network traffic was increased, and it was seen that with increase in the traffic rate, AODV performed better than the other two routing protocols and DSDV has performed better than AOMDV with increase in network traffic rate.

Comparison of throughput of a network using different routing protocols with variations in pause time

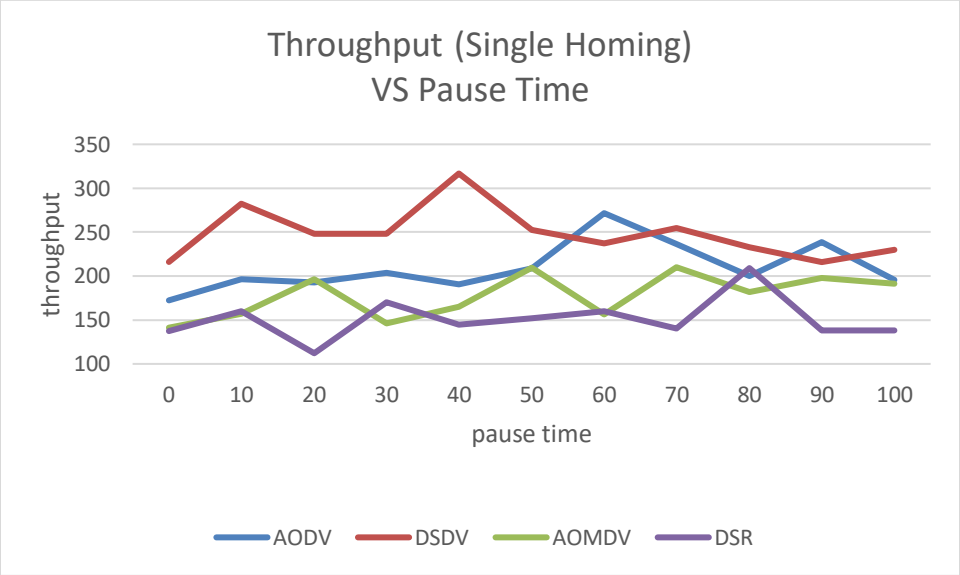

Figure 25

In the above graph for different routing protocols for a network using SCTP, it was seen that DSDV performed better than the other routing protocols with the increase in mobility among nodes and among the reactive protocols, AODV has performed better than DSR and also it has performed better than AOMDV.

Comparison of throughput of a network using different routing protocols with variations in pause time(multi homing)

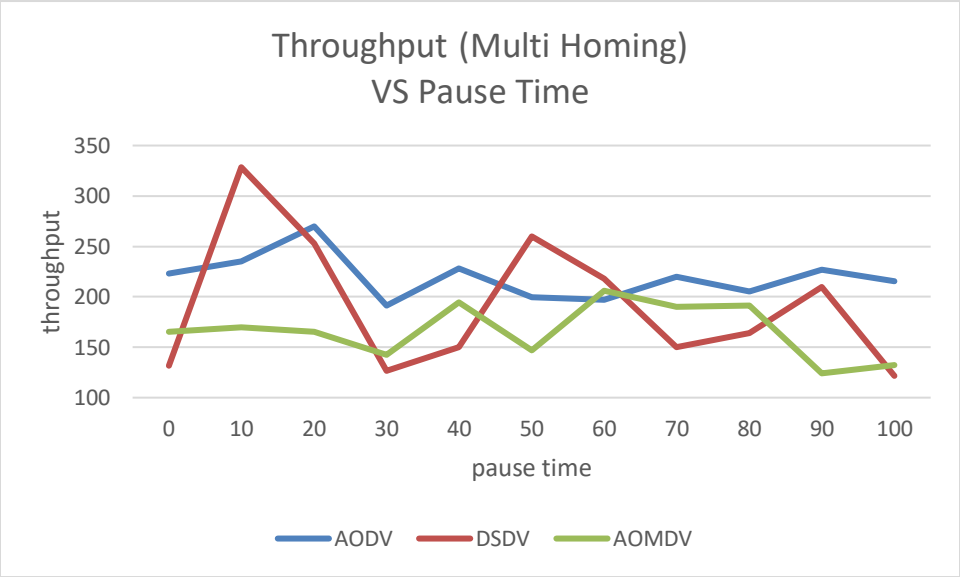

Figure 26

In figure 26, different routing protocols of a network using SCTP with its multi homing feature it can be seen that with the increase in mobility among nodes, AODV has performed better than the other two routing protocols. And DSDV has performed better than AOMDV with increase in mobility.

Comparison of end-to-end delay of a network using different routing protocols with variations in no. of nodes

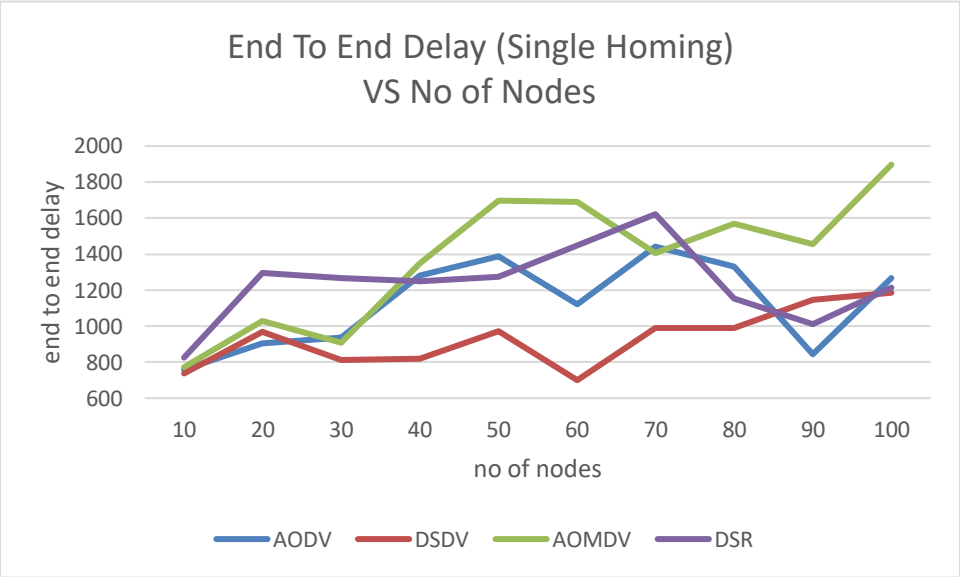

Figure 27

In figure 27, end to end delay of a network using SCTP, with increase in network traffic it was seen that DSDV has performed well than the other routing protocols and among the reactive routing protocols AODV has performed better than DSR with increase in network traffic and AOMDV has performed the worst with increase in network traffic rate.

Comparison of end-to-end delay of a network using different routing protocols with variations in no. of nodes(multi homing)

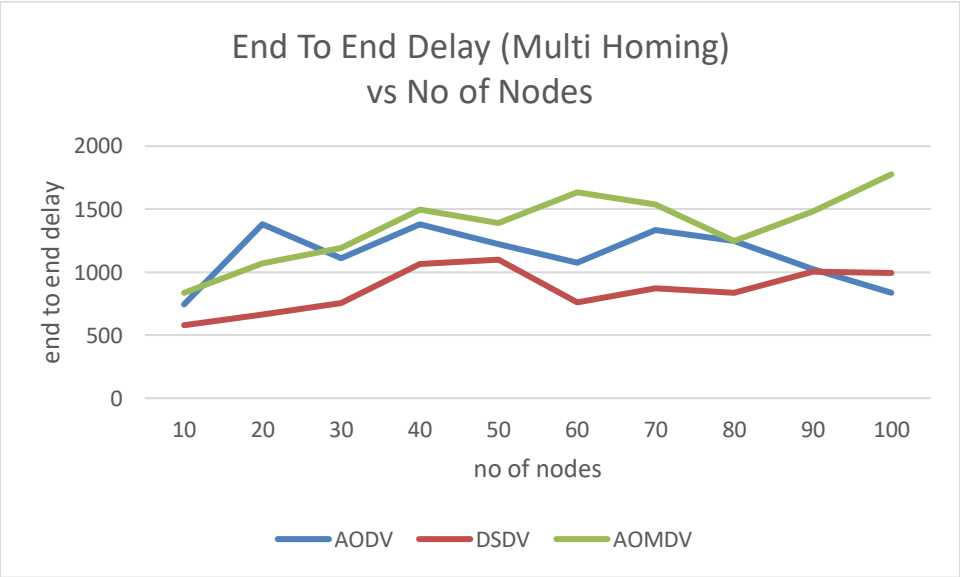

Figure 28

In figure 28, end to end delay for a network using SCTP with its multi homing feature it can be seen that DSDV has performed better than both AOMDV and AODV with increase in network traffic rate and that AOMDV has performed the worst among them with hike in traffic rate.

Comparison of end-to-end delay of a network using different routing protocols with variations in pause time

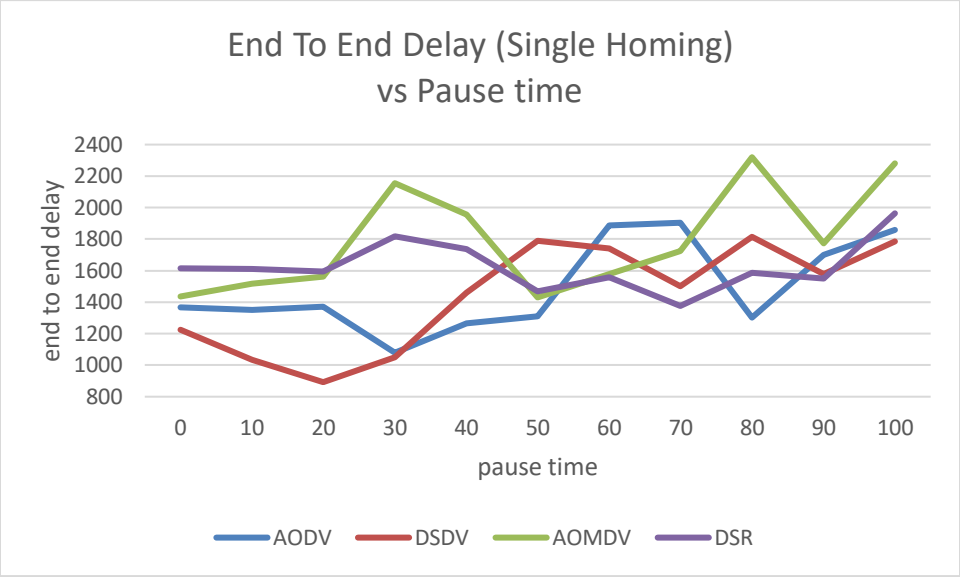

Figure 29

In figure 29, end to end delay for a network using SCTP, the mobility among the nodes was increased and it was seen that in an lower mobility scenario DSDV has performed better than the other three. However with the increase in mobility among the nodes, DSR has performed better than the other routing protocols and it was also seen that AOMDV has performed the worst.

Comparison of end-to-end delay of a network using different routing protocols with variations in pause time(multi homing)

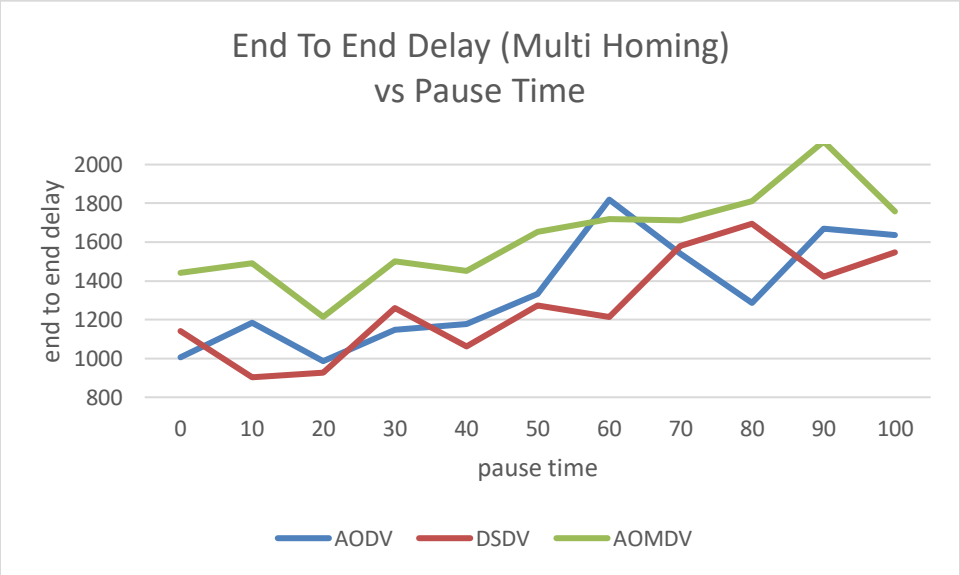

Figure 30

In figure 30, end to end delay of a network using SCTP with its multi homing feature, the mobility among the nodes was increased and it was seen that DSDV has performed better than the other two and that AOMDV has performed the worst among them.

CONCLUSION

In our project, the performance of routing protocols like AODV, DSDV, AOMDV and DSR in ad hoc network setups using SCTP is analyzed.

This analysis is done with respect to the variation in network traffic rate and mobility among the nodes.

For analysis purpose, three parameters were chosen: 1. packet delivery ratio, 2.Throughput, 3.end to end delay.

To simulate the networks supporting the above mentioned protocols, NS2.35 simulator was used.

To set up an ad-hoc network, traffic generation files and scenario files will be generated. And these generated files will be given as input to the TCL file containing the configuration of nodes which is required to simulate the required network.

Traffic generation files are the files which contain the connection setup for either multi homing or single homing feature of SCTP.

To generate these traffic generation files, a TCL file is used. The TCL file is written in such a way that by giving the number of connections involved in the network and the total nodes involved as input to the TCL file, the traffic generation files can be generated for both multi homing and single homing features of SCTP.

Increase in network traffic rate is done by increasing the number of connection parameter which is given to the TCL file which generates the traffic generation file.

Scenario file generation is done in the same way as that of traffic generation file.

The simulated results are recorded in a trace file. Then the required fields to find packet delivery ratio, throughput and end to end delay are extracted from the trace file using AWK program and those parameters are found out.

These network parameters are used to plot the graphs and the possible conclusions about the performance of these routing protocols under these network conditions are given for each graph drawn.

This analysis has been done for both single homing and multi homing features of SCTP and the comparative analysis between these two are done by plotting graphs using these network parameters and the conclusion about the performance of both of these features are also given.

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6. NS Manual

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