A Report on NS3 project

CSE 322

Load Balancing Routing Protocol for Wireless Mesh Network

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Contents

1 Introduction

This report briefly illustrates the infrastructure of my ns3 term project of the CSE-322 course.

This project is based on AODV routing algorithm.In AODV routing algorithm,only hop count is measured.But in this project,in order to achieve a better routing,I have changed RREQ and RREP header to measure the packets in the node buffer of each node to ensure better End-to-End Delay and decrease Packet Drop Ratio.

2 Papers

The papers that were used in this project:

- https://thesai.org/Publications/ViewPaper?Volume=12&Issue=8&Code=IJACSA&SerialNo=71
- https://www.researchgate.net/publication/281525355_Congestion_Avoidance_in_AODV_Routing_Protocol_Using_Buffer_Queue_Occupancy_and_Hop_Count
- https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3537517

3 Task A

I had wireless high rate(802.11)[mobile] and wireless low rate(802.15.4)[static] networks for task A.

4 Task A1: Wireless High Rate(802.11)[mobile]

For wireless high rate(802.11)[mobile],"Manet-Routing-Compare.cc" file was changed.Flowmonitor was used for accessing the metrics.
The parameters are listed below:

- Number of nodes: 15,20,30,40,50
- No of sinks : 2,3,4,5,6,7
- Mobility Model: RandomWaypointMobilityModel
- Propagation Model: ConstantSpeedPropagationDelay
- Propagation Loss Model: Friis Position
- Allocator: RandomRectangularPositionAllocator (300*1500)m*m
- SinkPort : 9
- Wifi(physical):YansWifiPhyHelper
- Wifi(channel):YansWifiChannelHelper
- Mac: AdhocWifiMAC Mac Standard: 802.11B
- Txp(Wifi Tx Power)= 7.5
- DataRate(bps):100,200,300,400,500
- DsssRate: 11Mbps
- Total Simulation Time: 100 seconds

- Node speed: 5m/s ,10m/s,15m/s,20m/s,25m/s
- Node pause time: 0
- Packet Size: 64 bytes
- Transport Layer: OnOffHelper(UdpSocketFactory)
- Protocol: AODV routing protocol

5 Task A1: Wireless High Rate(802.11)[mobile]

Metric:Flows

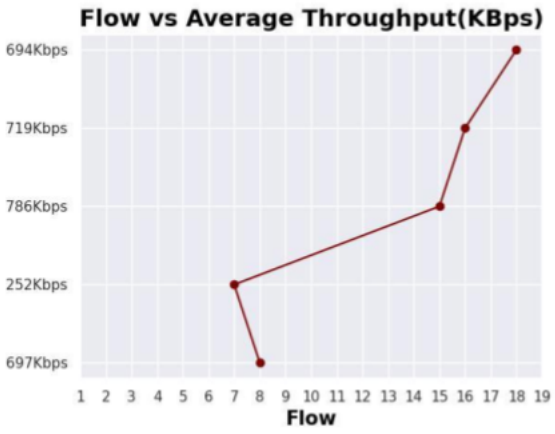
Number of Sinks were changed to increase the flows.
The graph generation by changing the metrics are showen below:
(PaPerSec - Packets Per Second)

NumofNodes	SpeedofNodes	PaPerSec	Flows
15	5	100	8,7,15,16,18
20	10	200	26,31,35,53,82
30	15	300	174,183,234,294,308
40	20	400	198,294,352,443,495
50	25	500	476,866,883,944,1173

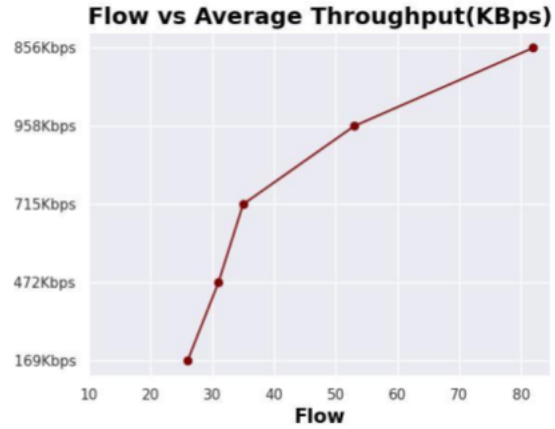
Table 1: Flows under variation

5.1 Graphs:AvgThroughput Vs Flows

As the number of sinks were being increased,the flows were increasing.Thus the capacity was increasing.That is why the Average throughput is rapidly increasing.When the capacity exceeds,throughput is decreasing.



Node=15,PPs=100,NS=5



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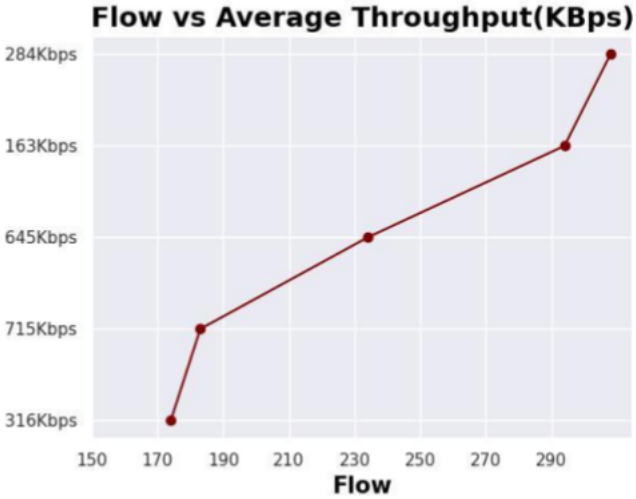

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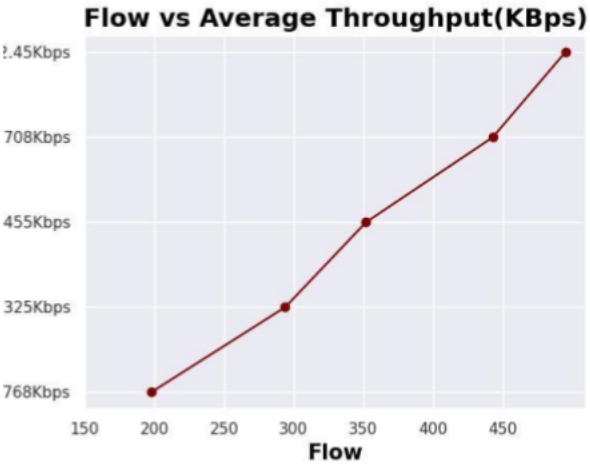


Node=40,PPs=400,NS=20

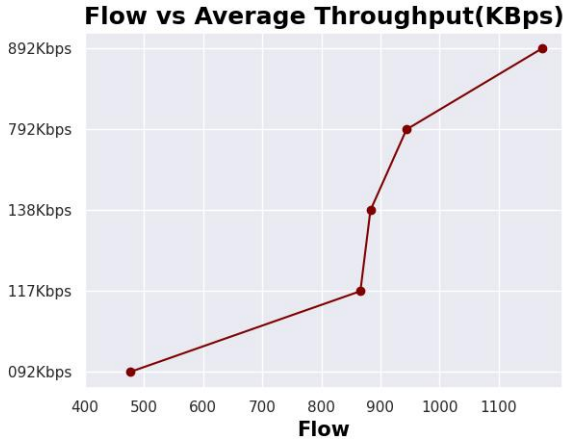
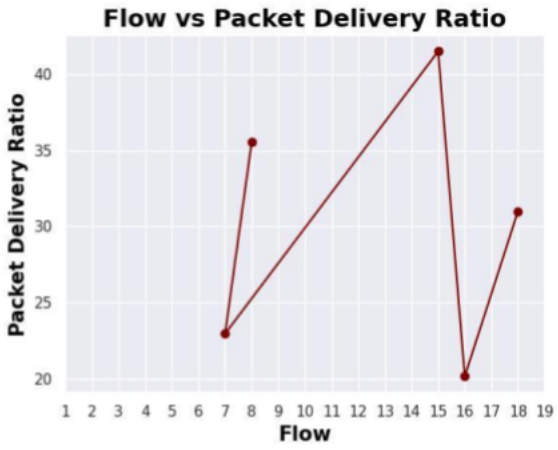


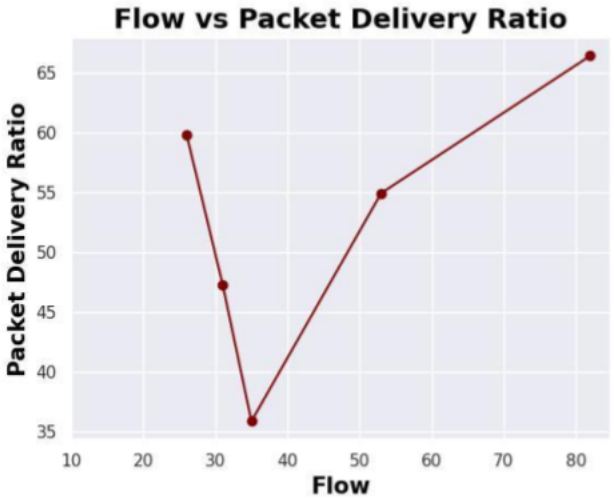
Figure 1: Nodes:50,SN=25,PPS=500

5.2 Graphs:Packet Delivery Ratio Vs Flows

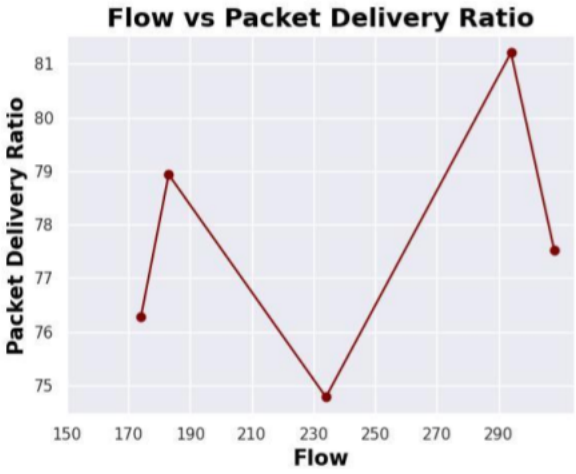
As the number of sinks were being increased,the flows were increasing.The capacity is different in each time.For the congestions,the graphs are not linear.



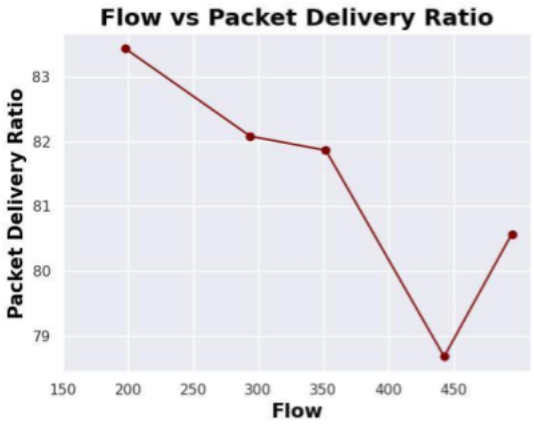
Node=15,PPs=100,NS=5



Node=20,PPs=200,NS=10



Node=30,PPs=300,NS=15



Node=40,PPs=400,NS=20

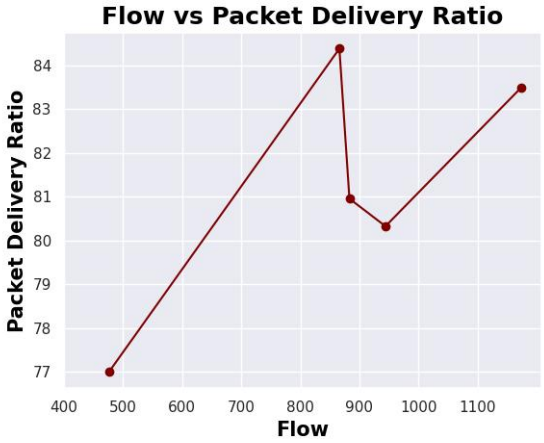
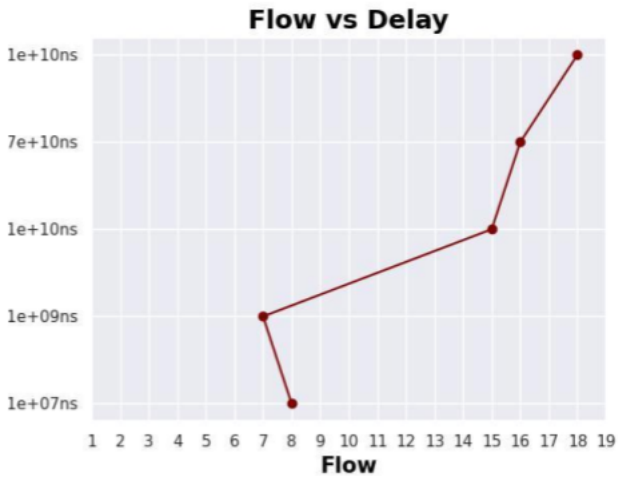


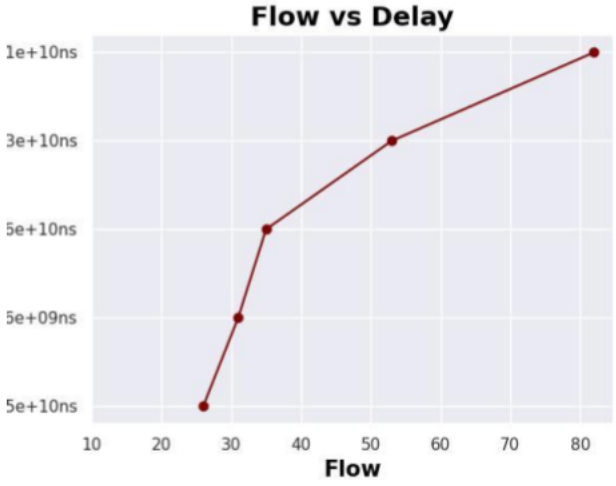
Figure 2: Nodes:50,SN=25,PPS=500

5.3 Graphs:Delay Vs Flows

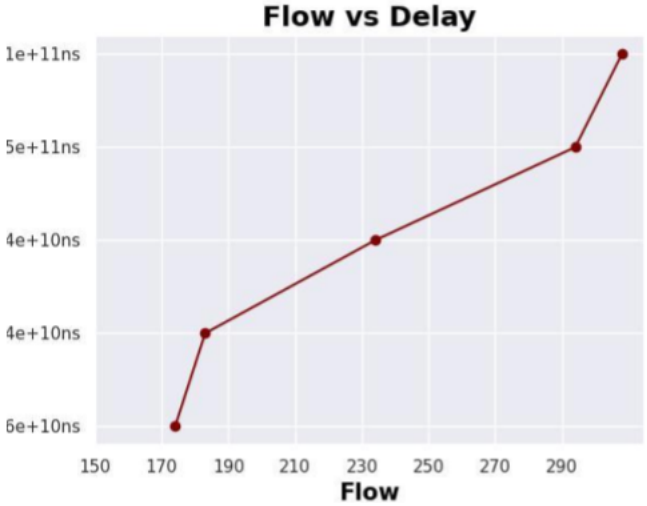
As the number of sinks were being increased,the flows were increasing.More number of packets are receiving,that is the delay is increasing.



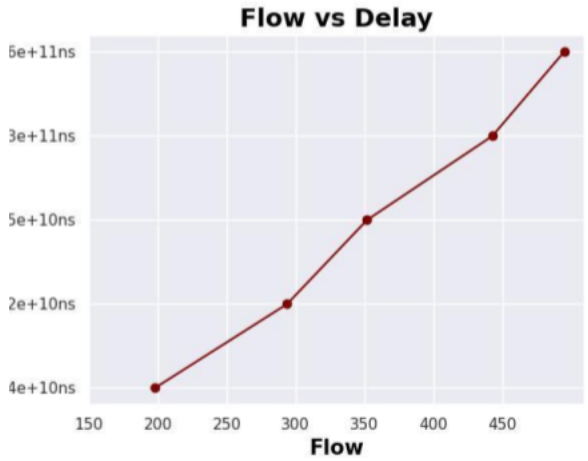
Node=15,PPs=100,NS=5



Node=20,PPs=200,NS=10



Node=30,PPs=300,NS=15



Node=40,PPs=400,NS=20

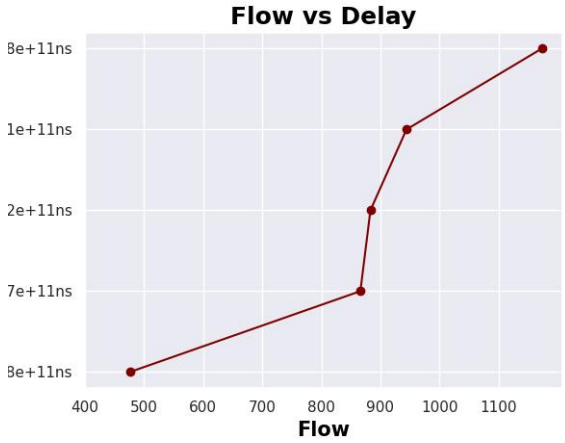
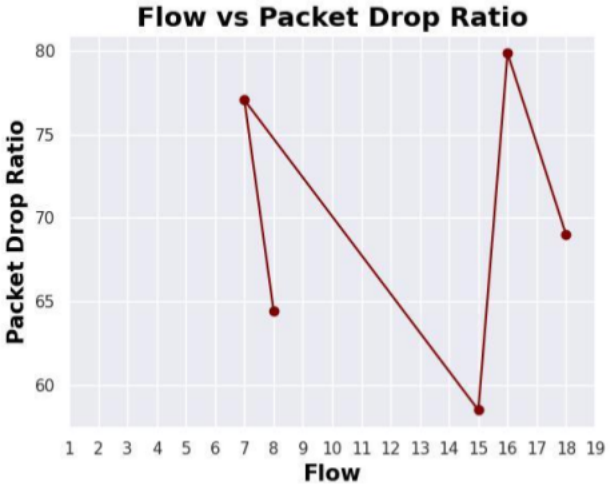


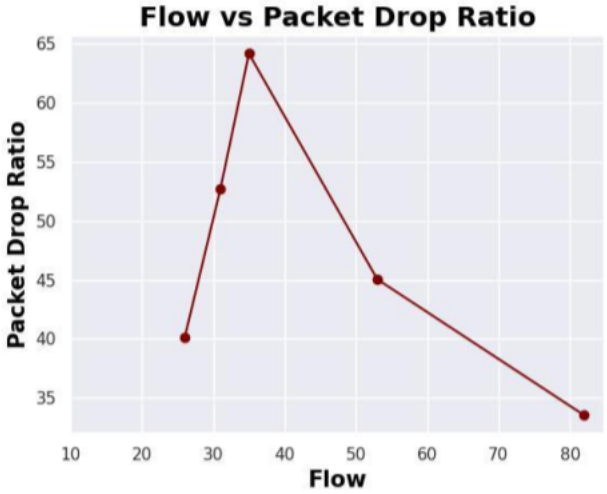
Figure 3: Nodes:50,SN=25,PPS=500

5.4 Graphs:Packet Drop Ratio Vs Flows

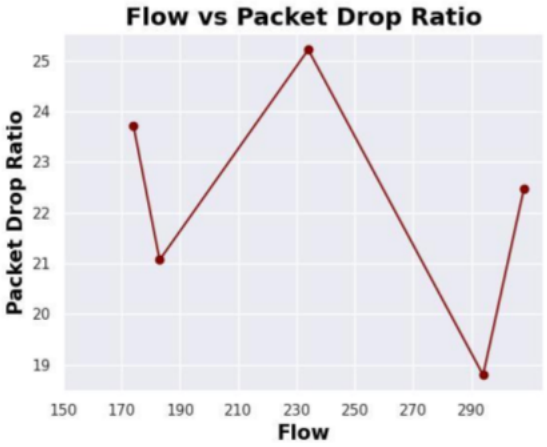
As the number of sinks were being increased,the flows were increasing.The capacity is different in each time.For the congestions,when the buffer size exceeds,the packets are dropp.



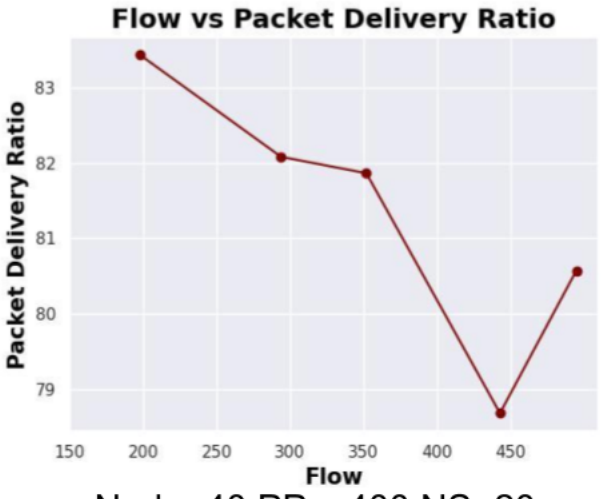
Node=15,PPs=100,NS=5



Node=20,PPs=200,NS=10



Node=30,PPs=300,NS=15



Node=40,PPs=400,NS=20

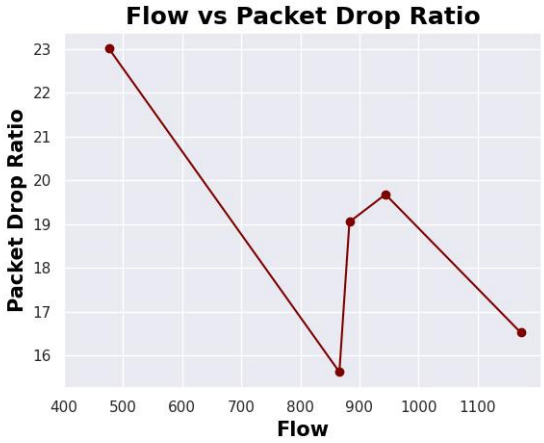
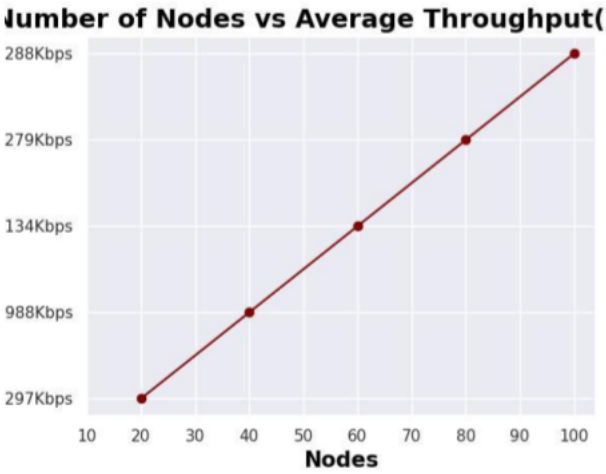


Figure 4: Nodes:50,SN=25,PPS=500

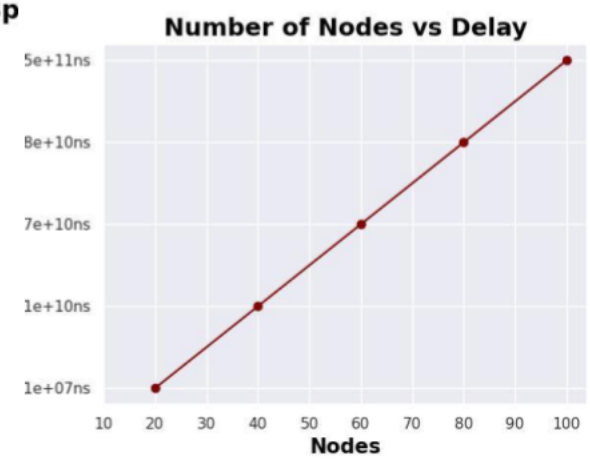
6 Task A: Wireless High Rate(802.11)[mobile]

Number Of Nodes

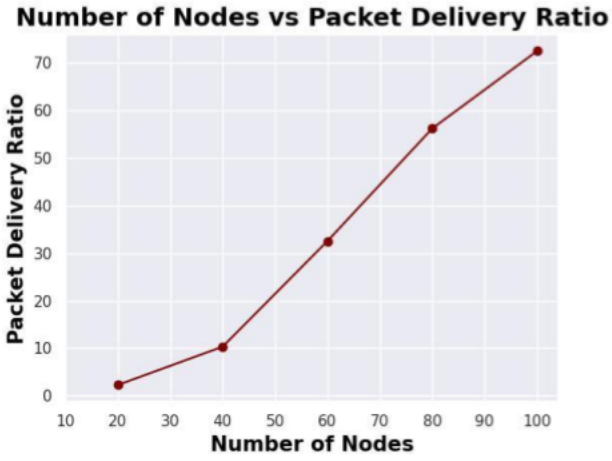
Number of nodes are varied while NodeSpeed is 25,Packets Per Second is 500 and number of sink is 4.When node is increasing,the flow is increasing,throughput and packet delivery ratio are increasing as nodes did not exceed the capacity.



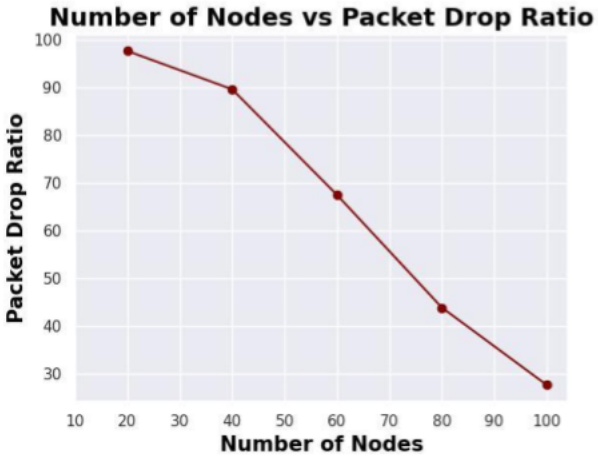
PPs=500,NS=25,Sinks=4



PPs=500,NS=25,Sinks=4



PPs=500,NS=25,Sinks=4

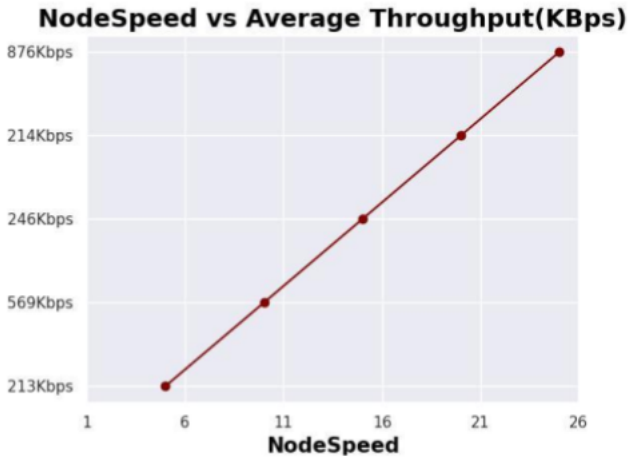


PPs=500,NS=25,Sinks=4

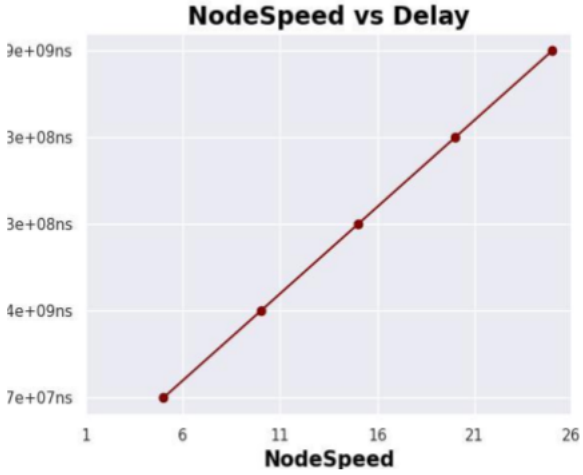
7 Task A1: Wireless High Rate(802.11)[mobile]

Node Speed

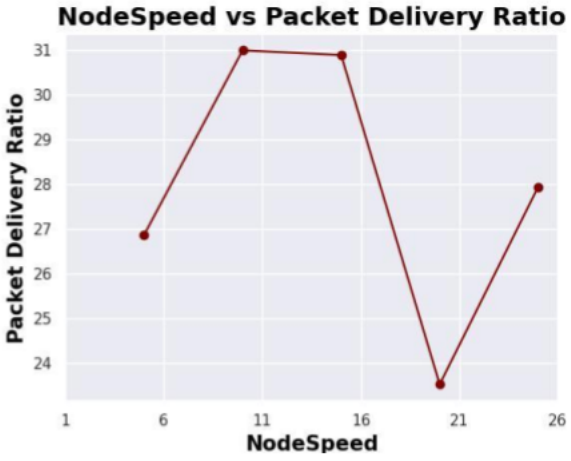
Number of nodes are varied while Node number is 25,Packets Per Second is 100 and number of sink is 3.Here,packet delivery ratio and the packet drop ratio is different as when the node-Speed is 20,a lot of packet drops for the increasing mobility of the nodes.



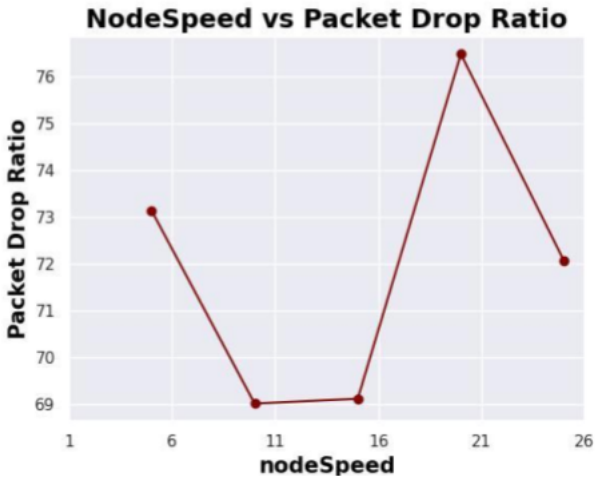
PPs=100,Nodes=15,Sinks=3



PPs=100,NS=15,Sinks=3



PPs=100,Nodes=15,Sinks=3

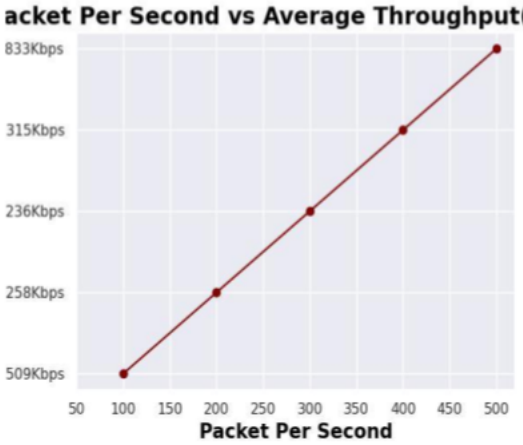


PPs=100,NS=15,Sinks=3

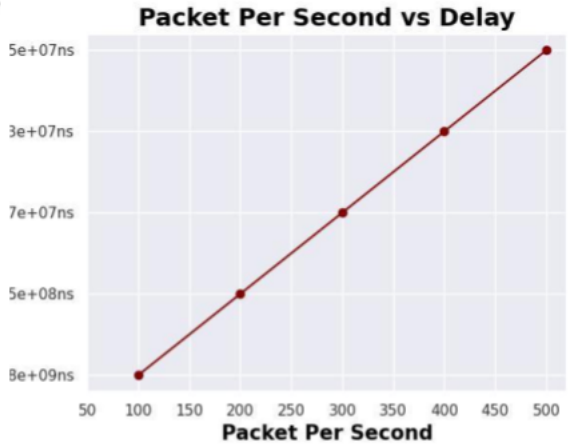
8 Task A1: Wireless High Rate(802.11)[mobile]

Packets Per Second

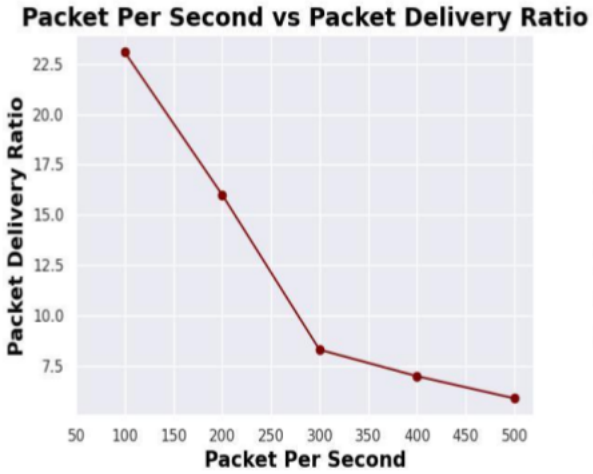
Number of nodes are varied while Node number is 20,Node Speed is 10 and number of sink is 4.As the packets per second increases,data rate is increasing but not parallely,that is why Packet Delivery ratio falls rapidly.



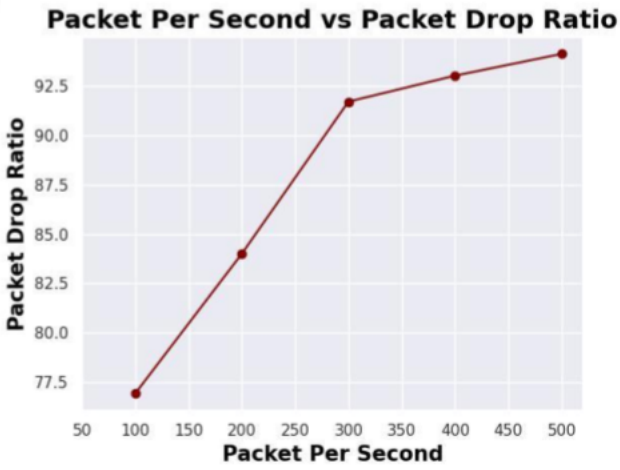
Nodes=20,NS=10,Sinks=4



Nodes=20,NS=10,Sinks=4



Nodes=20,NS=10,Sinks=4



Nodes=20,NS=10,Sinks=4

9 Task A2: Wireless Low Rate(802.15.4)[static]

For wireless low rate(802.15.4)[mobile],
lrwpan files were used.Flowmonitor was used for accessing the metrics.
The parameters are listed below:

- Number of nodes: 10,20,40,60,80
- Number of Flows : 10,20,30,40,50
- Mobility Model: ConstantPositionMobilityModel
- Propagation Loss Model: RangePropagationLossModel(MaxRange=80)
- Allocator: GridPositionAllocator
- NetDevice: LrWpanHelper
- Standard: 802.15.4
- TCP buffer = 2 MB
- DataRate(bps):10kbps,20kbps,30kbps,40kbps,50kbps
- Packets Per Second : 100,200,300,400,500
- DsssRate: 11Mbps
- CoverageArea(DeltaX,DeltaY)=(20,20),(40,40),(60,60),(80,80),(100,100)
- Total Simulation Time: 100 seconds
- Node pause time: 0
- Transport Layer: TcpL4Protocol::SocketType
- Protocol: Default routing protocol

10 Task A2: Wireless Low Rate(802.15.4)[static]

Metric:Flows

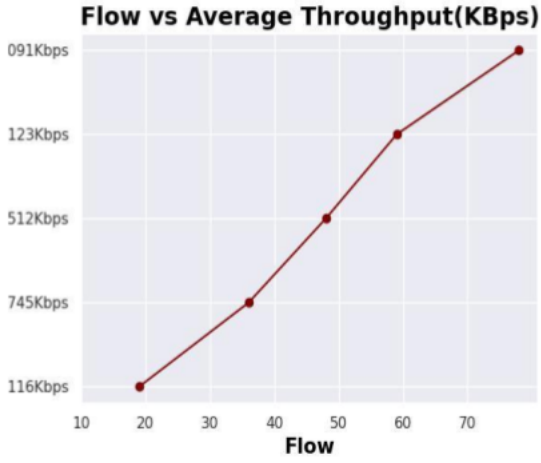
Number of Sinks were changed to increase the flows.
The graph generation by changing the metrics are showen below:

NumofNodes	CoverageArea	PacketsPerSec	Flows
10	(80,80)	100	10,20,30,40,50
20	(80,80)	200	10,20,30,40,50
40	(80,80)	300	10,20,30,40,50
60	(80,80)	400	10,20,30,40,50
80	(80,80)	500	10,20,30,40,50

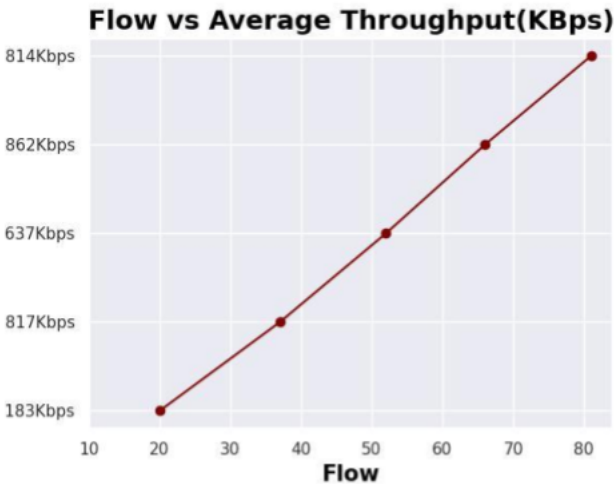
Table 2: Flows under variation

10.1 Graphs:AvgThroughput Vs Flows

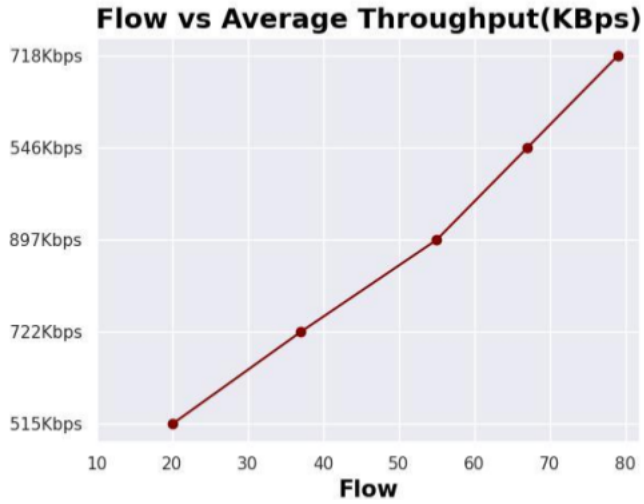
As the number of flows were being increased,the sinkports were increasing.Thus every metric is showing positive and steady graph
.



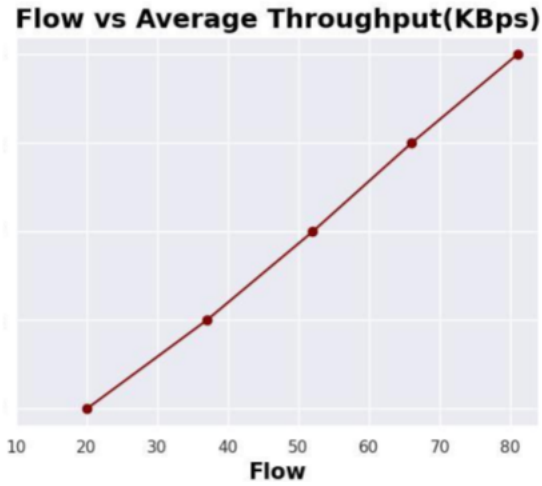
Nodes=10,PPs=100,CA=(80,80)



Nodes=20,PPs=200,CA=(80,80)



Nodes=40,PPs=300,CA=(80,80)



Nodes=60,PPs=400,CA=(80,80)

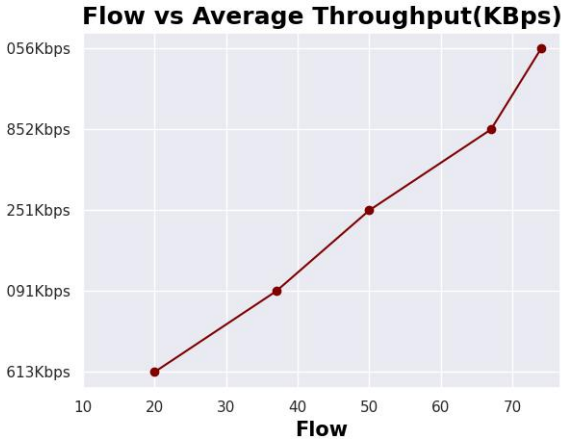
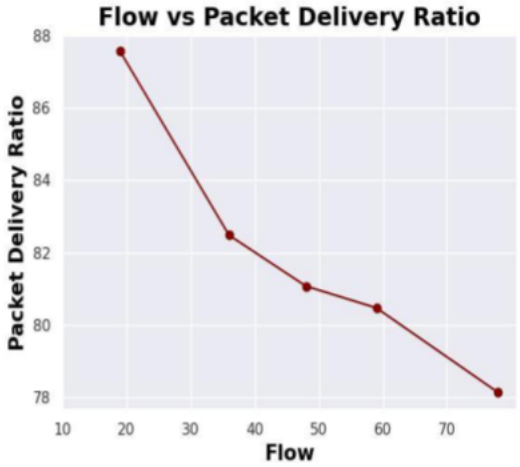


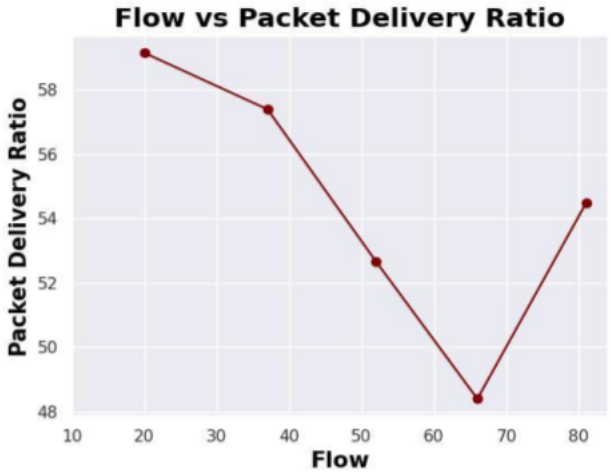
Figure 5: Nodes:80,CA=(80,80),PPS=500

10.2 Graphs:Packet Delivery Ratio Vs Flows

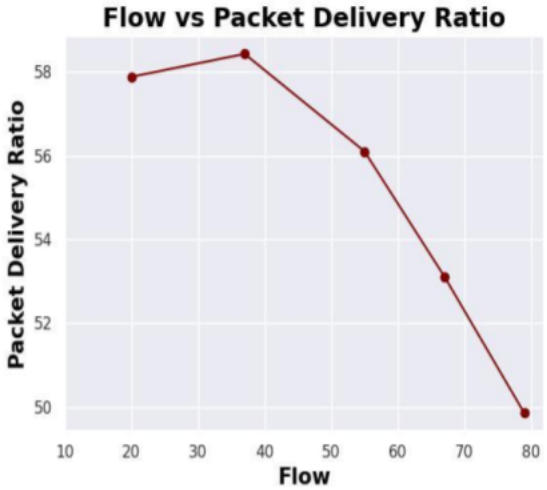
As the number of flows were being increased,the sinkports were increasing.For different nodes,when the flows are increasing,the packet delivery ratio is decreasing.



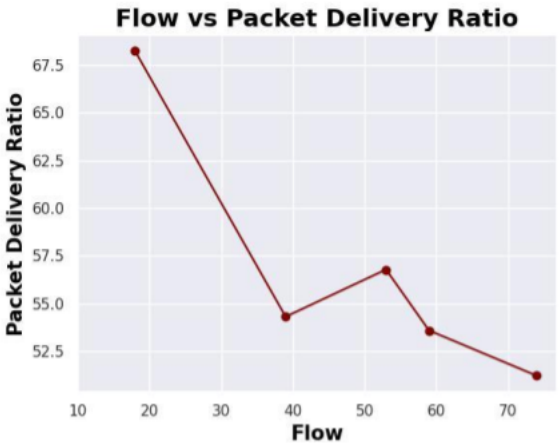
Nodes=10,PPs=100,CA=(80,80)



Nodes=20,PPs=200,CA=(80,80)



Nodes=40,PPs=300,CA=(80,80)



Nodes=60,PPs=400,CA=(80,80)

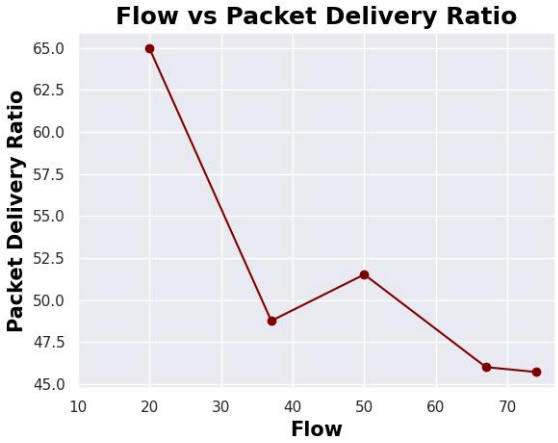
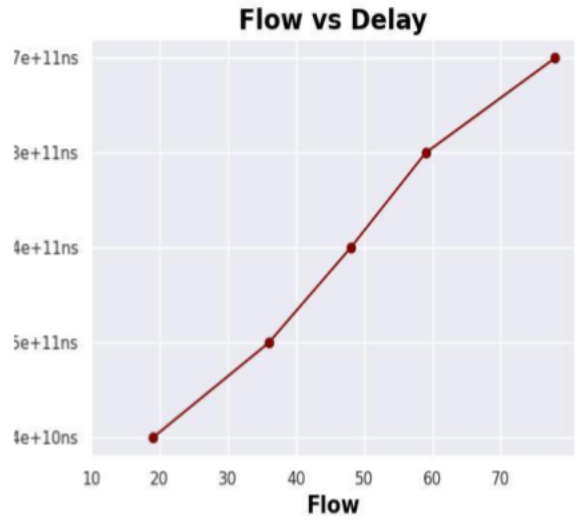


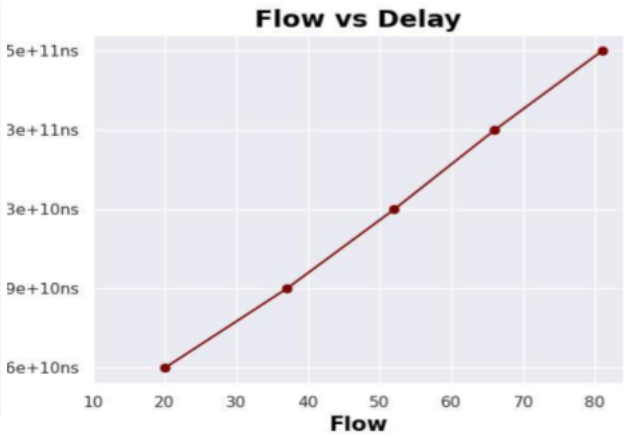
Figure 6: Nodes:80,CA=(80,80),PPS=500

10.3 Graphs:Delay Vs Flows

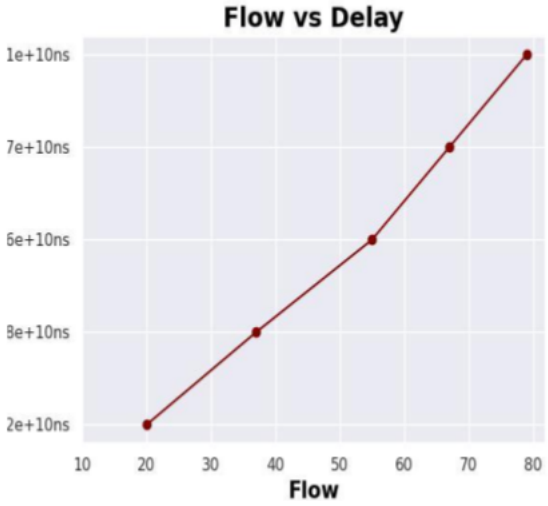
As the number of flows were being increased,the sinkports were increasing.For increasing flows,the delays are increasing in packet transmission.



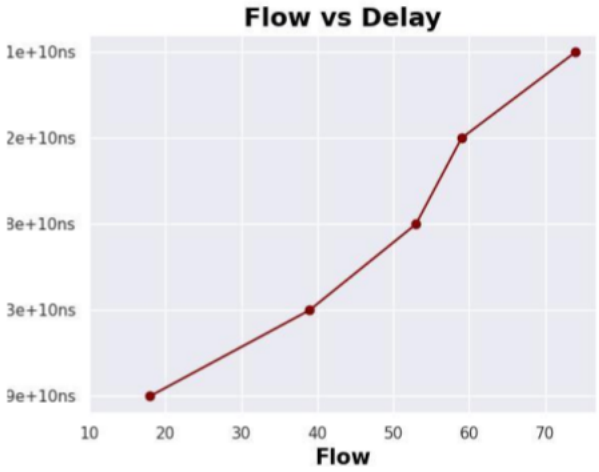
Nodes=10,PPs=100,CA=(80,80)



Nodes=20,PPs=200,CA=(80,80)



Nodes=40,PPs=300,CA=(80,80)



Nodes=60,PPs=400,CA=(80,80)

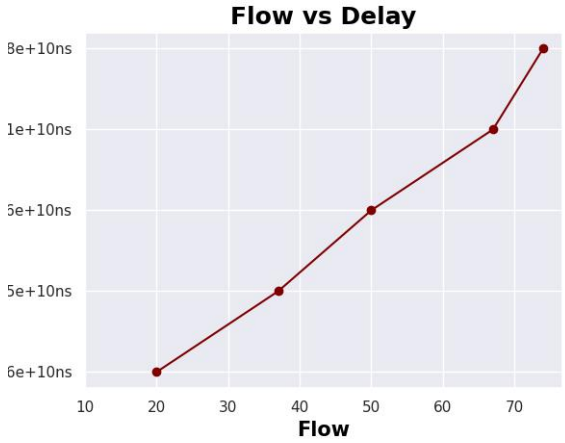
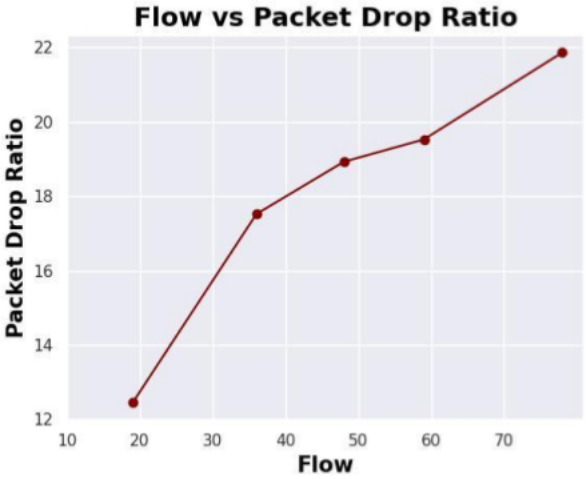


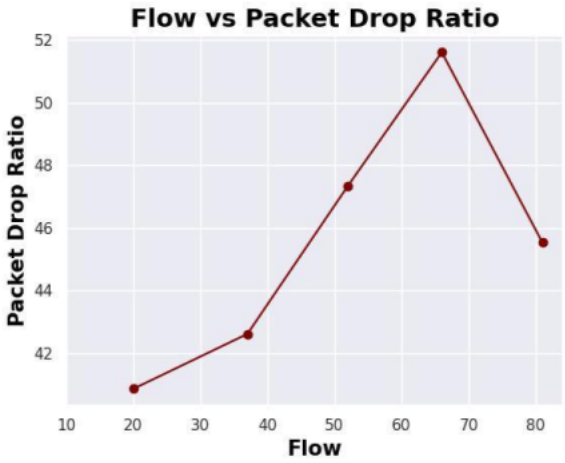
Figure 7: Nodes:80,CA=(80,80),PPS=500

10.4 Graphs:Packet Drop Ratio Vs Flows

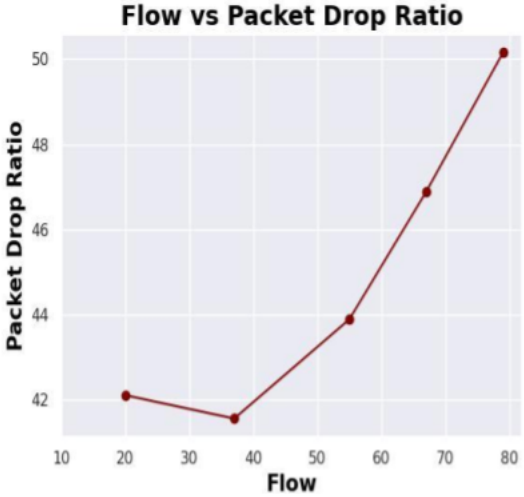
As the number of flows were being increased,the sinkports were increasing.For different nodes,when the flows are increasing,the packet drop ratio is increasing.



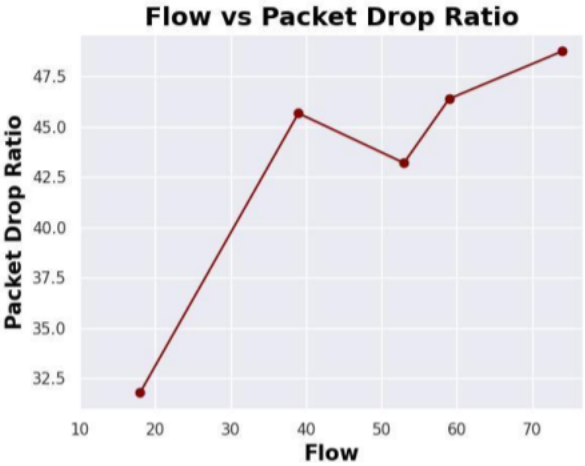
Nodes=10,PPs=100,CA=(80,80)



Nodes=20,PPs=200,CA=(80,80)



Nodes=40,PPs=300,CA=(80,80)



Nodes=60,PPs=400,CA=(80,80)

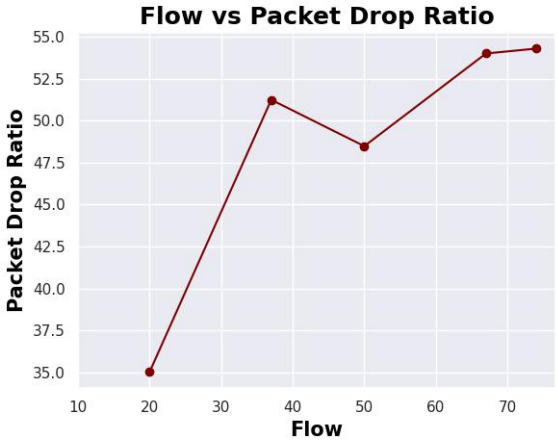
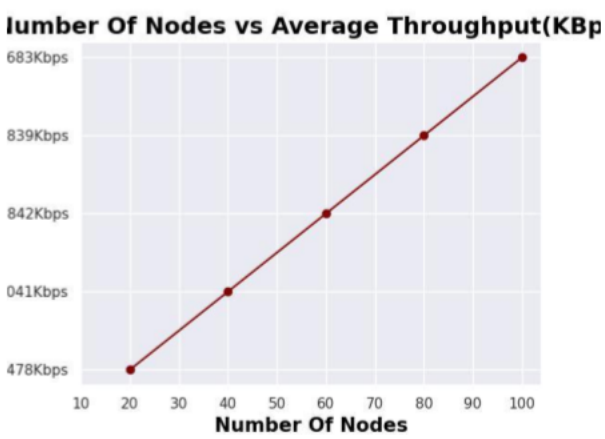


Figure 8: Nodes:80,CA=(80,80),PPS=500

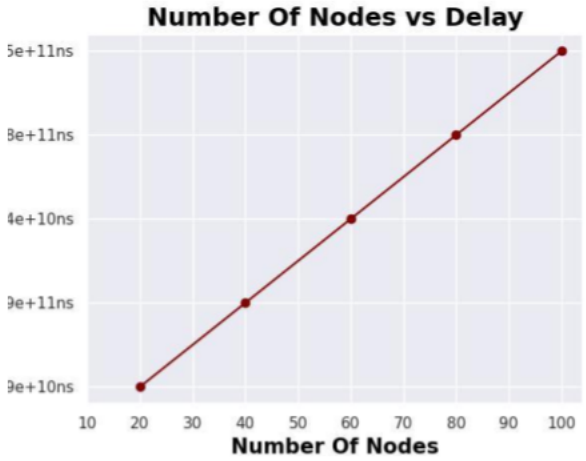
11 Task A2: Wireless Low Rate(802.15.4)[static]

Number Of Nodes

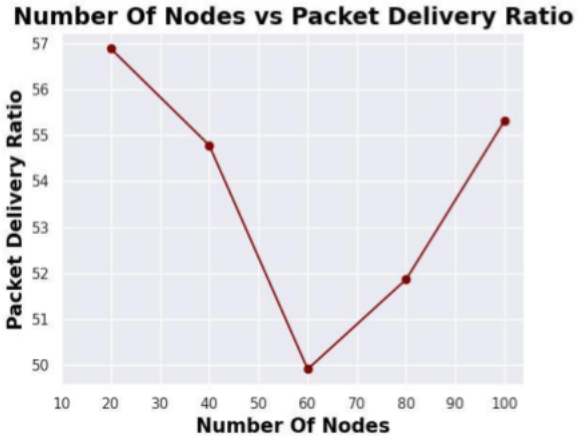
Number of nodes are varied while Coverage Area is (80,80),Packets Per Second is 200 and number of flows is 20.When node number is 60,a lot of packet drop because of the congestion.



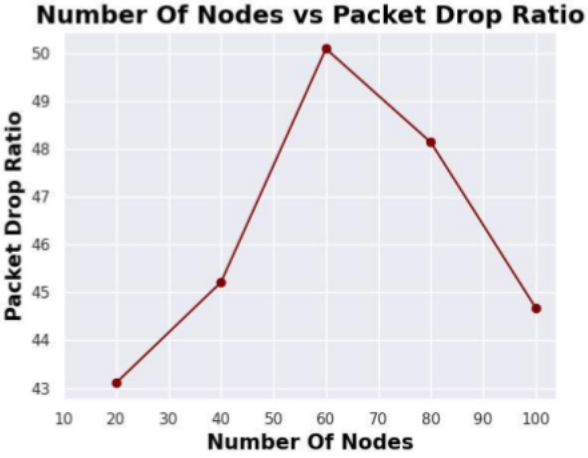
flows=20,PPs=200,(Dx,Dy)=(80,80)



flows=20,PPs=200,(Dx,Dy)=(80,80)



flows=20,PPs=200,(Dx,Dy)=(80,80)

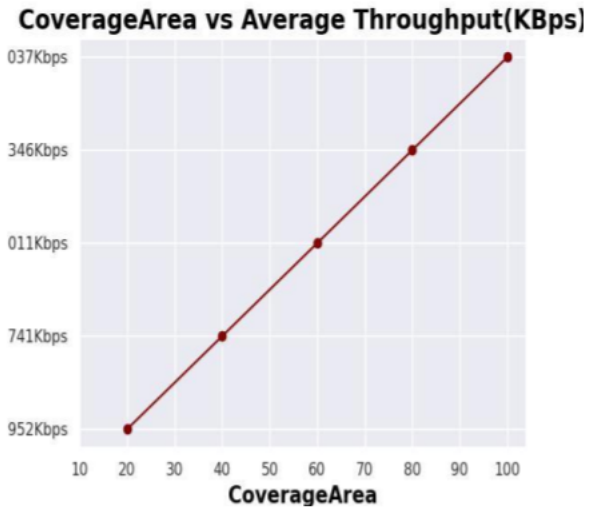


flows=20,PPs=200,(Dx,Dy)=(80,80)

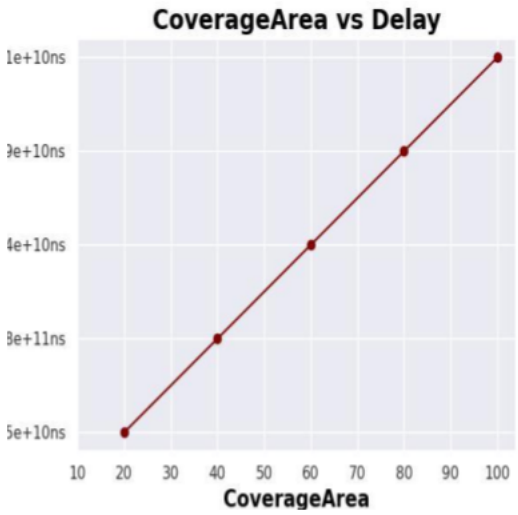
12 Task A2: Wireless Low Rate(802.15.4)[static]

Coverage Area

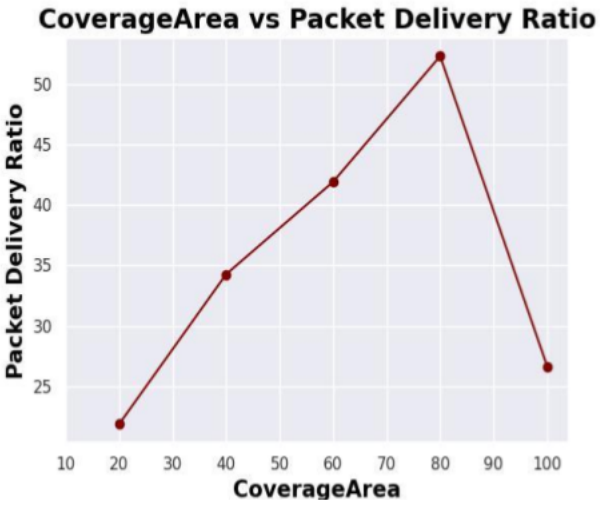
Number of nodes are varied while Node number is 40,Packets Per Second is 200 and number of flows is 40.When the coverage area is (deltaX,deltaY):(100,100),packets are dropping a lot as it is out of the maximum range which is 80.Though the graph is not clear in throughput,the last value is 37kbps which is pretty low than the other throughput results.



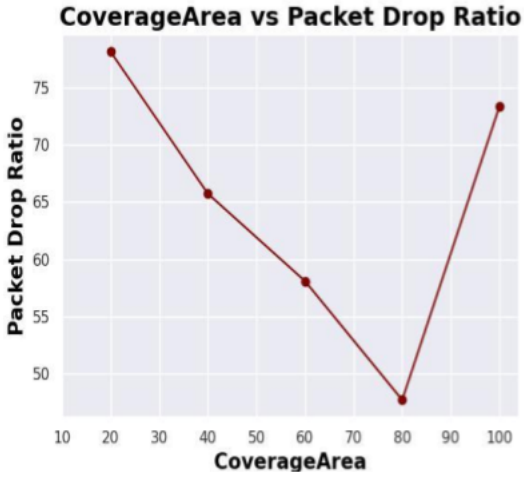
flows=40,Nodes=40,PPs=200



flows=40,Nodes=40,PPs=200



flows=40,Nodes=40,PPs=200

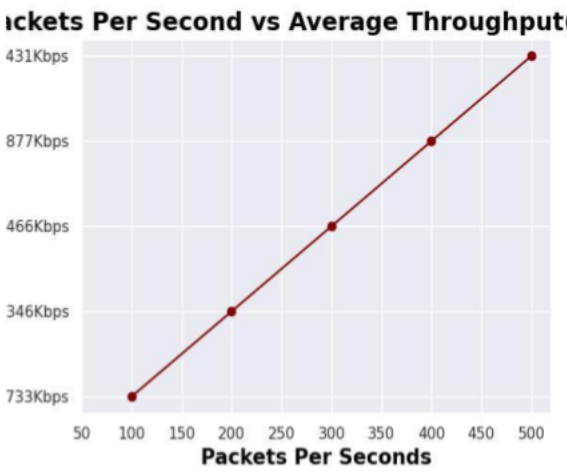


flows=40,Nodes=40,PPs=200

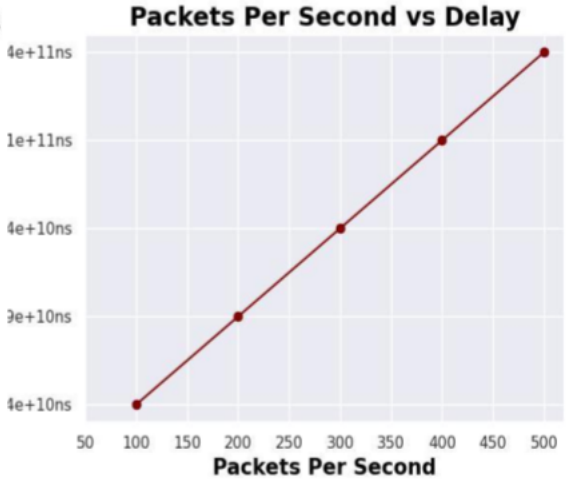
13 Task A2: Wireless Low Rate(802.15.4)[static]

Packets Per Second

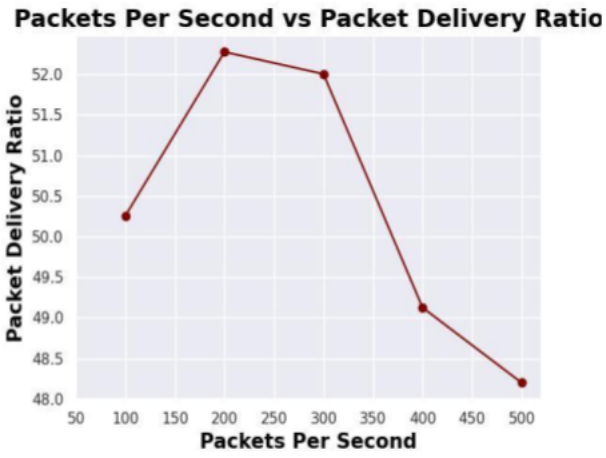
Number of nodes are varied while Node number is 40,Coverage Area is (80,80) and number of flows is 40.As the packets per seconds increases,a lot of packets drop as they exceeds the buffer size.Also the throughput is 431kbps for 500 PPs,which is also low.



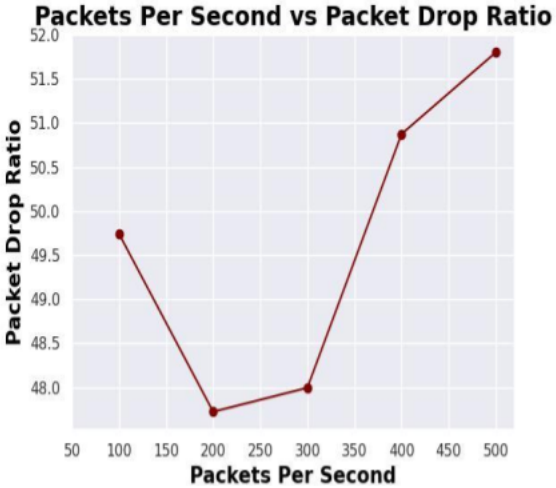
flows=40,Nodes=40,(Dx,Dy)=(80,80)



flows=40,Nodes=40,(Dx,Dy)=(80,80)



flows=40,Nodes=40,(Dx,Dy)=(80,80)



flows=40,Nodes=40,(Dx,Dy)=(80,80)

14 Overview of the proposed algorithm

The proposed algorithm is Load Balancing AODV.
In AODV,only hopcount is measured to find a route.But if the nodes of the route is heavily loaded,then the packets can be dropped and also the end to end delay can be pretty high.As there is no way in AODV to measure the node buffer size to mitigate this problem,this proposed algorithm can decrease the end to end delay and also it can decrease the packet drop ratio.

15 Modifications made in the simulator

Modifications were made mainly in aodv model.
The files are:

- aodv-packet.h
- aodv-packet.cc
- aodv-routing-protocol.h
- aodv-routing-protocol.cc

In aodv-packet.h, forwardBuffer was inserted in RREQ header and backBuffer was inserted in RREP header.

In aodv-packet.cc,RreqHeader constructor and RrepHeaderconstructor were overloaded.Also,the values of forwardBuffer and backBuffer were initialized.

16 Modifications made in the simulator

The proposed algorithm is applied in aodv-routing-protocol.cc. If the source while sending the packet does not know about the destination,it broadcasts RREQ in its neighbouring nodes through SendRequest() function.While sending request,the value of forwardBuffer is 0.
When an intermediate node gets that RREQ,it updates its forwardBuffer by its queueSize(number of packets present in the buffer) in RecvRequest() function.

When the queueSize is bigger than the threshold buffer size (75% of the total buffer size),the node does not broadcast the RREQ,as it is pretty jammed.So, that particular node does not participate in that route.

Again,if the node has the information of the destination node,it sends RREP to the source node.While sending RREP, the backBuffer is 0.

When an intermediate node gets the RREP ,it compares it bufferSize with the threshold buffer size(75% of the total buffer size) and if it is bigger than the threshold,it does not send the RREP to the next node,as the node is jammed.That is how the buffer size of the nodes are checked while choosing the destination route from the source and better end to end delay can be achieved.

17 Parameters for Running the Simulation

Main changed file is MANET-ROUTING-PROTOCOL.cc.Flowmonitor was used for accessing the metrics.
The parameters are listed below:

- Number of nodes:25,36,49,64,81,121
- No of sinks : 7
- Mobility Model: RandomWaypointMobilityModel
- Propagation Model: ConstantSpeedPropagationDelay
- Propagation Loss Model: Friis Position
- Allocator: RandomRectangularPositionAllocator (1500*1500)m*m
- sinkPort = 9
- Wifi(physical):YansWifiPhyHelper
- Wifi(channel):YansWifiChannelHelper
- Mac: AdhocWifiMAC Mac Standard: 802.11B
- Txp(Wifi Tx Power)= 7.5
- DataRate: 2048bps
- DsssRate: 11Mbps
- Total Simulation Time: 300 seconds
- Node speed: 15m/s
- Node pause time: 0
- Packet Size: 512 bytes

- Transport Layer: OnOffHelper(UdpSocketFactory)
- Protocol: Modified-AODV routing protocol

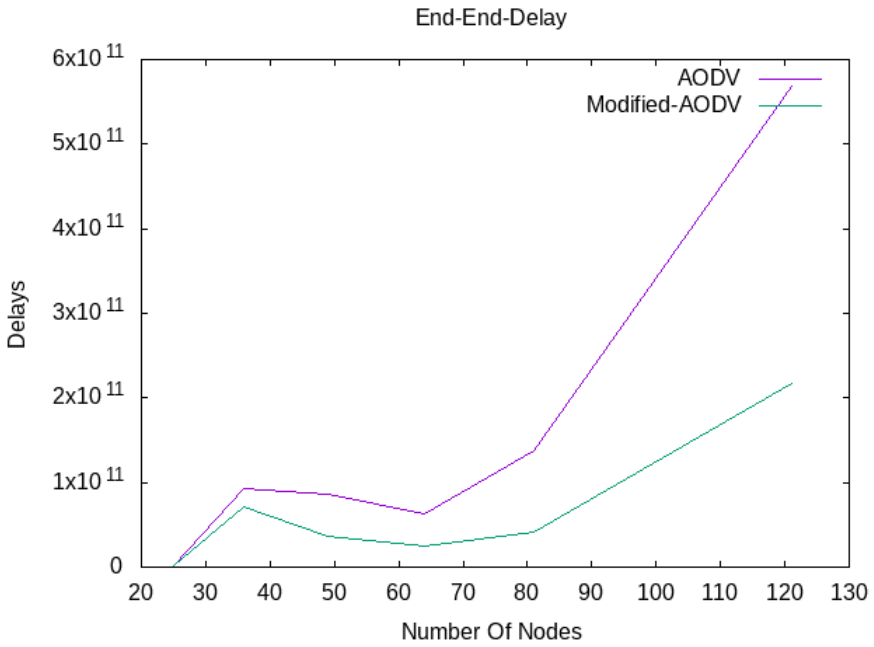
18 Results with graphs(Summary Findings)

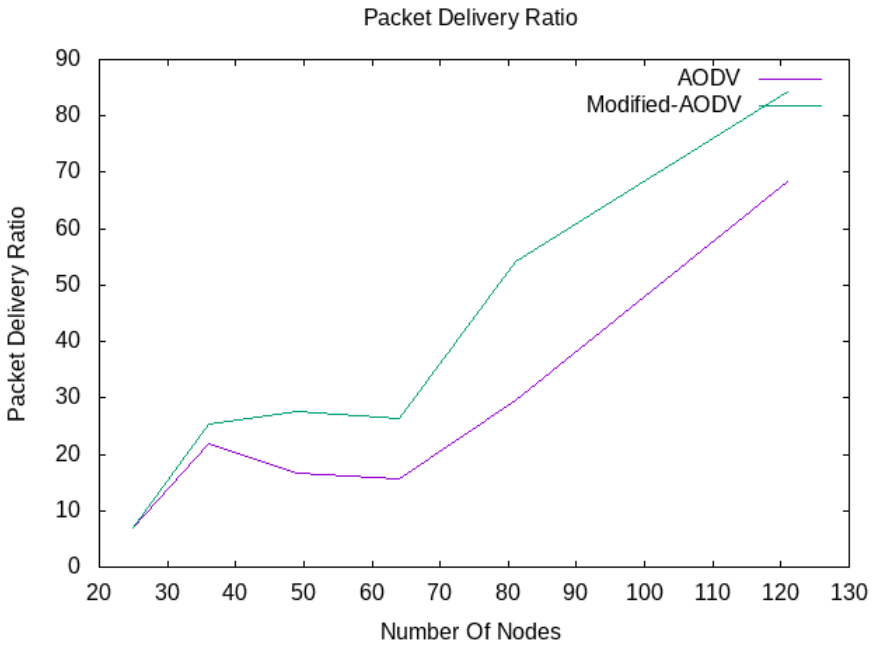
The improved metrics are end-to-end delay ,Packet Drop Ratio and Packet Delivery Ratio.

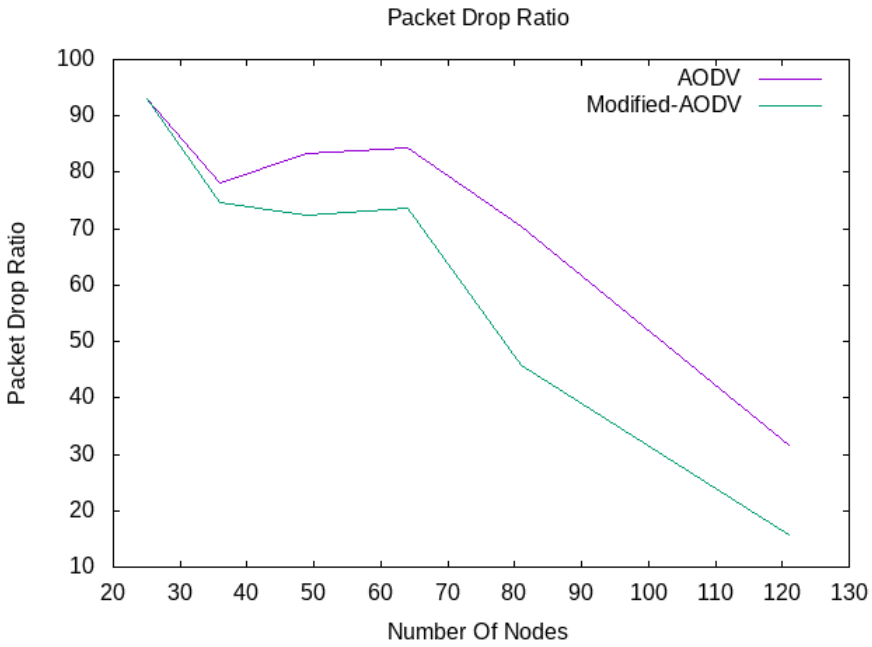
The proposed algorithm gives better routes as the packets do not have to wait in line for long.That is why end-to-end delay is decreased in the the modified algorithm.

The packets are delivered more and the packet delivery ratio drops.

Metrics Vs Node density is measured here.




Packet Delivery Ratio
AODV
Modified-AODV
Packet Delivery Ratio
Number Of Nodes
0
10
20
30
40
50
60
70
80
90
20
30
40
50
60
70
80
90
100
110
120
130


Packet Drop Ratio
AODV
Modified-AODV
Packet Drop Ratio
Number Of Nodes
10
20
30
40
50
60
70
80
90
100
20
30
40
50
60
70
80
90
100
110
120
130

19 Graphs from the Paper

In order to compare the results,here are the graphs from the paper. (My graphs differ from the paper as all the parameters are not mentioned in the paper and the flows are different.But the graphs have desired answers.Also they are generated in ns2.) Parameters in the paper are :

- Number of Nodes : 25,36,49,64,81,121
- Wifi Standard : 802.11b
- Simulation Area : (1500 * 1500)m*m
- Packet Size : 512 bytes
- Simulation time : 300 secs

Metrics Vs Node density graphs are:

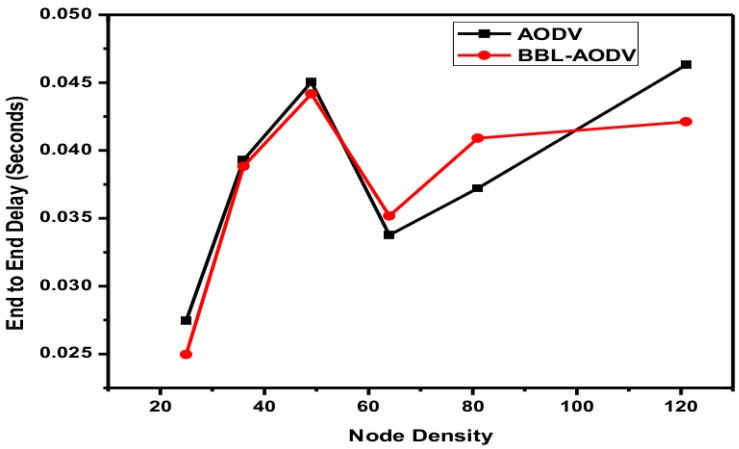


Figure 3 Variation of End to End Delay v/s node densities

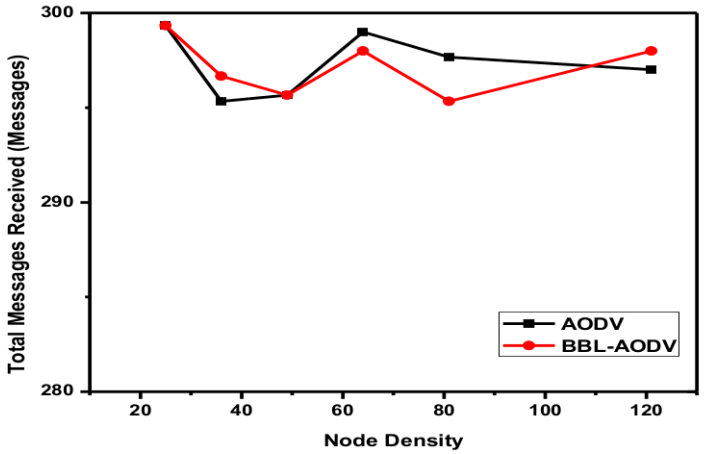


Figure 2 Variation of total messages received v/s node densities

20 Conclusion

We received immense help from our supervisor and other course teachers. It was very much helpful for learning network simulations.