CSE-322

Final Report on NS2 Project

Submitted by-

Somonindro Roy

Student ID : 1805049

Section: A

Networks under simulation: (1805049 % 8 = 1)

- Wireless 802.11 (static)
- Wireless 802.15.4 (static)

Parameters under variation:

For both networks (Wireless 802.11 static and Wireless 802.15.4 static), I varied

- The number of nodes as 20, 40, 60, 80 and 100
- The number of flows as 10, 20, 30, 40 and 50
- The number of packets per second as 100, 200, 300, 400 and 500
- Coverage area (square coverage are varying one side as Tx_range, 2 x Tx_range, 3 x Tx_range, 4 x Tx_range, and 5 x Tx_range)

Metrics variation for each parameter variation:

In both cases, I measured the following metrics and plotted graphs –

- Network throughput
- End-to-end delay
- Packet delivery ratio (total # of packets delivered to end destination / total # of packets sent)
- Packet drop ratio (total # of packets dropped / total # of packets sent)
- Energy consumption

Problems of basic AODV Protocol:

Ad-hoc On-Demand Distance Vector (AODV) is a reactive protocol where routes are created only when they are needed. When a route is needed, it broadcasts its RREQ packet to all of its neighbors. As a result, a network becomes clogged with duplicate RREQ packets that are repeated repeatedly even though most of the time only one RREQ packet is required to find a route. Due to congestion, these repeated RREQ packets may cause data packets to be dropped.

Modifications made in the NS2 simulator:

I mainly made two modifications here.

• Modify in AODV protocol

Modified files : aodv.h and aodv.cc

R-AODV uses a randomized approach to divert routing packets from congested paths to reliable and less congested paths. So, here the simulator is modified to limit the amount of broadcasting of RREQ packets comparing a random number with drop factor to decide whether to forward a RREQ packet or drop it. Thus it is expected to reduce congestion and hence to improve network throughput and delay metrics.

Step 1: Calculate drop_factor drop_factor = (1/(2^Hop_count_of_RREQ_packet))

Step 2: Calculate a random value in the range of 0 to 1.

Step 3: If (random_value > drop_factor) then broadcast/forward RREQ_packet else drop RREQ_packet

• Modify in Drop-tail queue

Modified files : drop-tail.h, drop-tail.cc, queue.h

Both networks (Wireless 802.11 static and Wireless 802.15.4 static) use Droptail queues in our experiment, which drop the packet that arrived initially when the queue fills up. Yet, occasionally a queue may contain redundant protocol packets that are not required.

We therefore consider those packets to be less significant than data packets. Hence, the least important packet is removed from the queue rather than the first one to arrive. The AODV packets in wireless are less important. Whereas, ARP packets are more important than those and Data Packets are the most important among these there types.

Consequences:

Here, I have compared basic AODV with the modifications of this paper and with my modified randomized AODV. All the three results are shown in graphs for comparison. The modified approach has significantly improved throughput and delivery ratio and decreased drop ratio and average delay in most of the cases. The results are shown in the graphs.

Graphs for Wireless 802.15.4 Static Network :

For wireless 802.15.4 static network simulation, I have used CBR in application layer (cbr_size 16 and cbr_rate 0.256Mb) and UDP in transport layer.

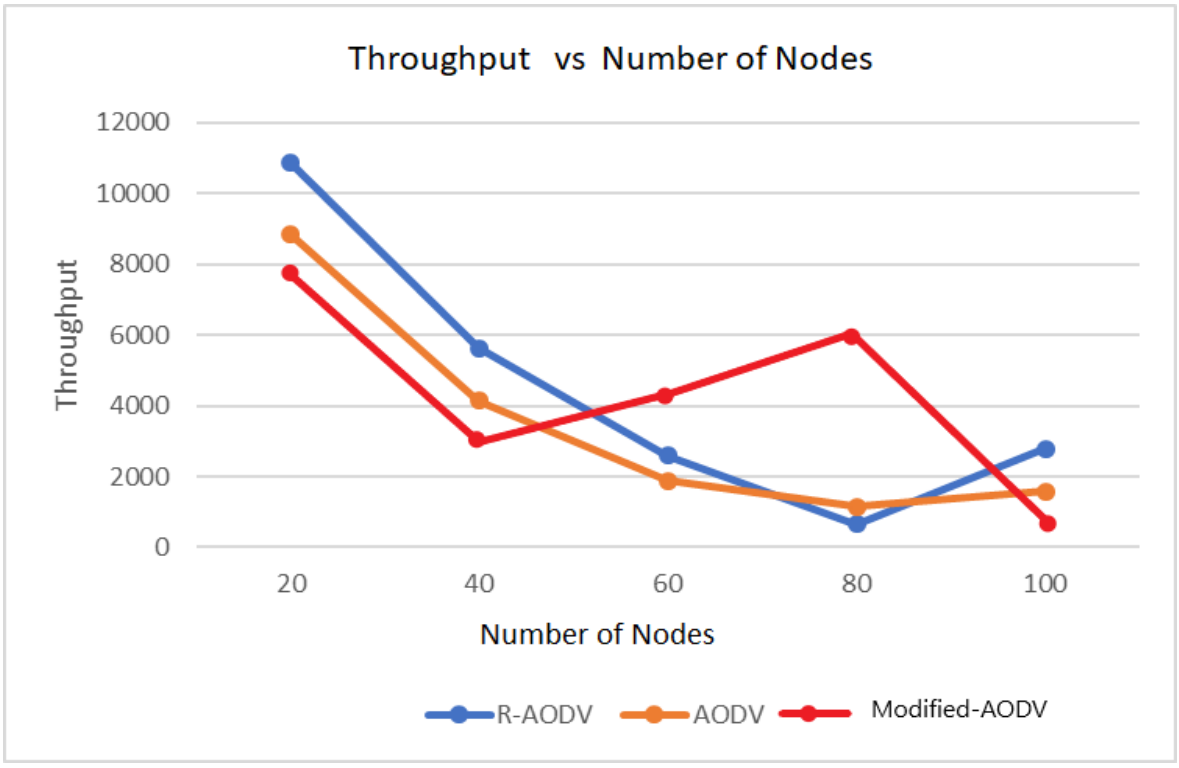
- Channel: Wireless channel
- Propagation: Two-ray ground
- Antenna: Omnidirectional
- Link: IEEE 802.15.4
- Queue: Drop-tail
- Routing: AODV
- Maximum packets in interface queue : 100
- Position: Grid
- Flow: Random source to random destination
- Number of nodes: Variable
- Number of flows: Variable
- Number of packets per seconds: Variable
- Coverage area: Variable

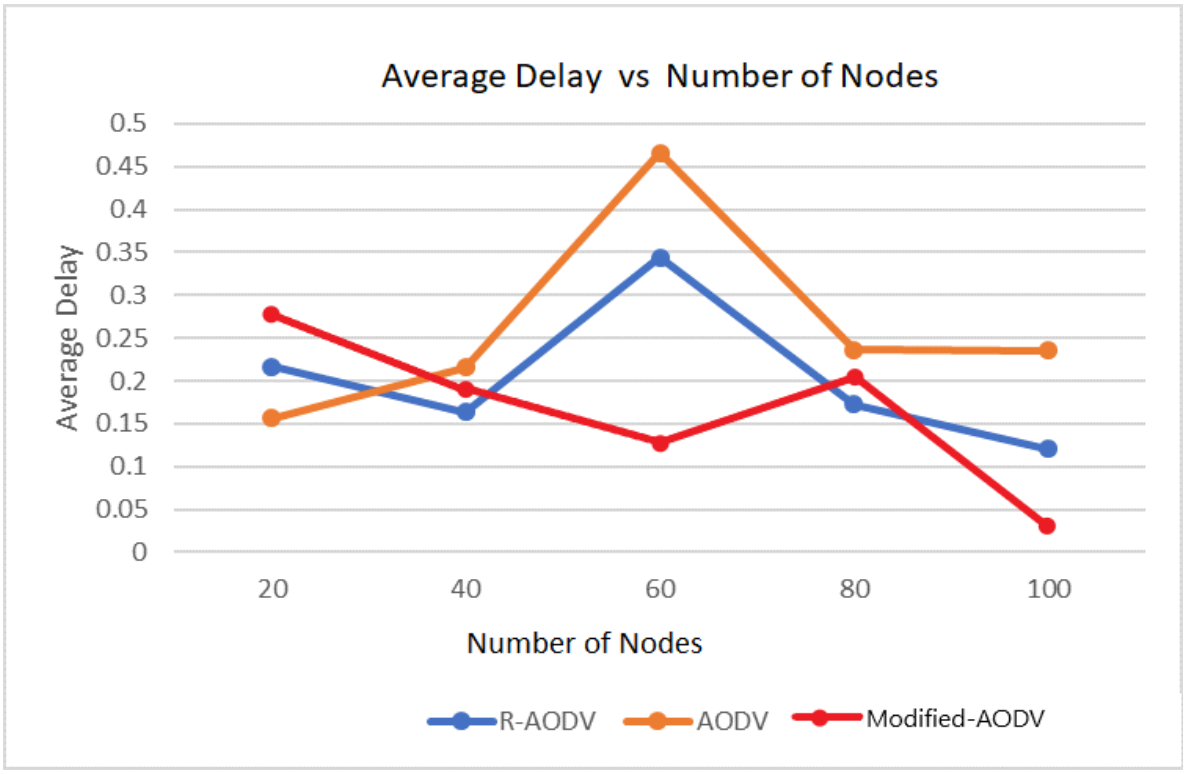
Varying Number of Nodes :

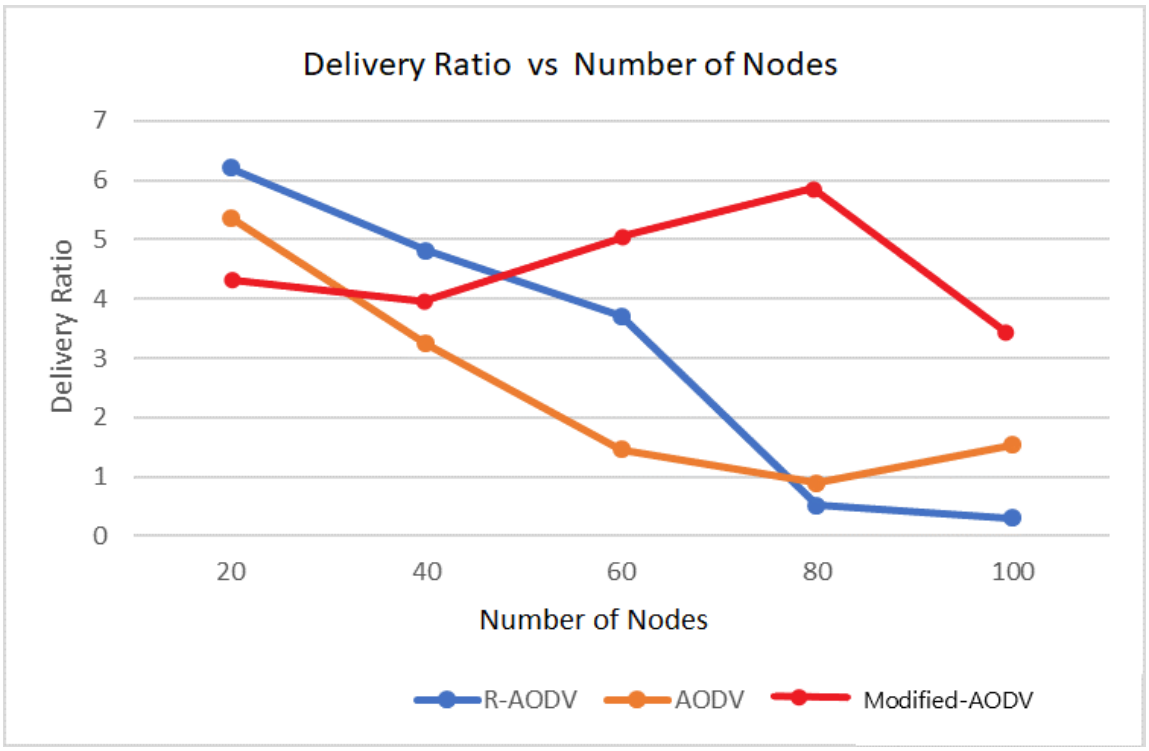
Number of Nodes varied as 20, 40, 60, 80 and 100

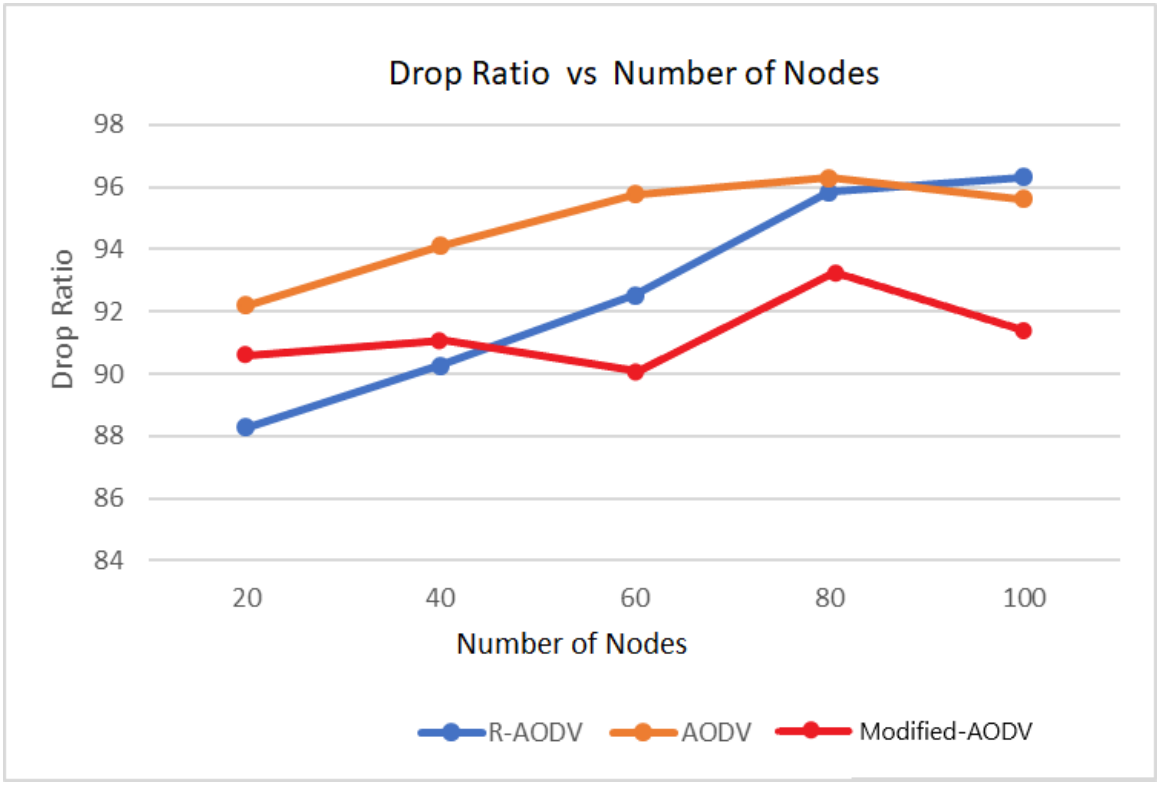
Baseline Parameters :

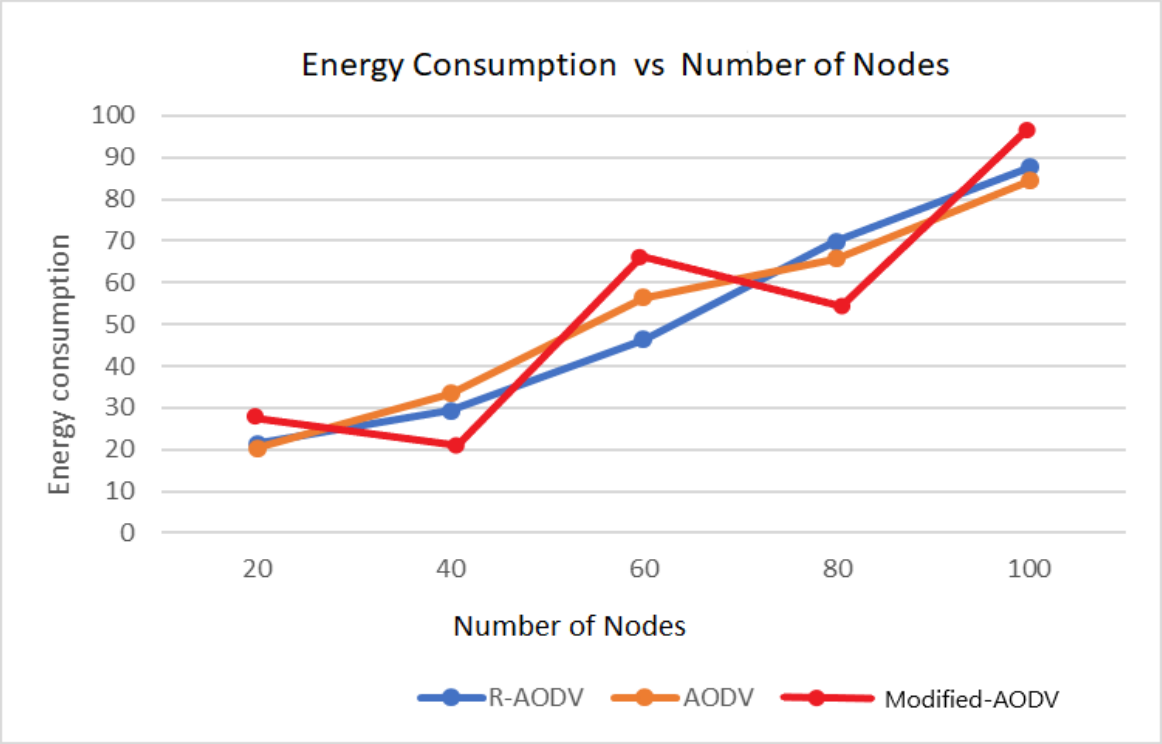
- Number of Flows = 10
- Number of Packets per Second = 100
- Coverage Area = 80


Throughput vs Number of Nodes
12000
10000
8000
6000
4000
2000
0
Throughput
20
40
60
80
100
Number of Nodes
R-AODV
AODV
Modified-AODV


Average Delay vs Number of Nodes
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Average Delay
20
40
60
80
100
Number of Nodes
R-AODV
AODV
Modified-AODV


Delivery Ratio vs Number of Nodes
Delivery Ratio
7
6
5
4
3
2
1
0
20
40
60
80
100
Number of Nodes
R-AODV
AODV
Modified-AODV


Drop Ratio vs Number of Nodes
Drop Ratio
98
96
94
92
90
88
86
84
20
40
60
80
100
Number of Nodes
R-AODV
AODV
Modified-AODV

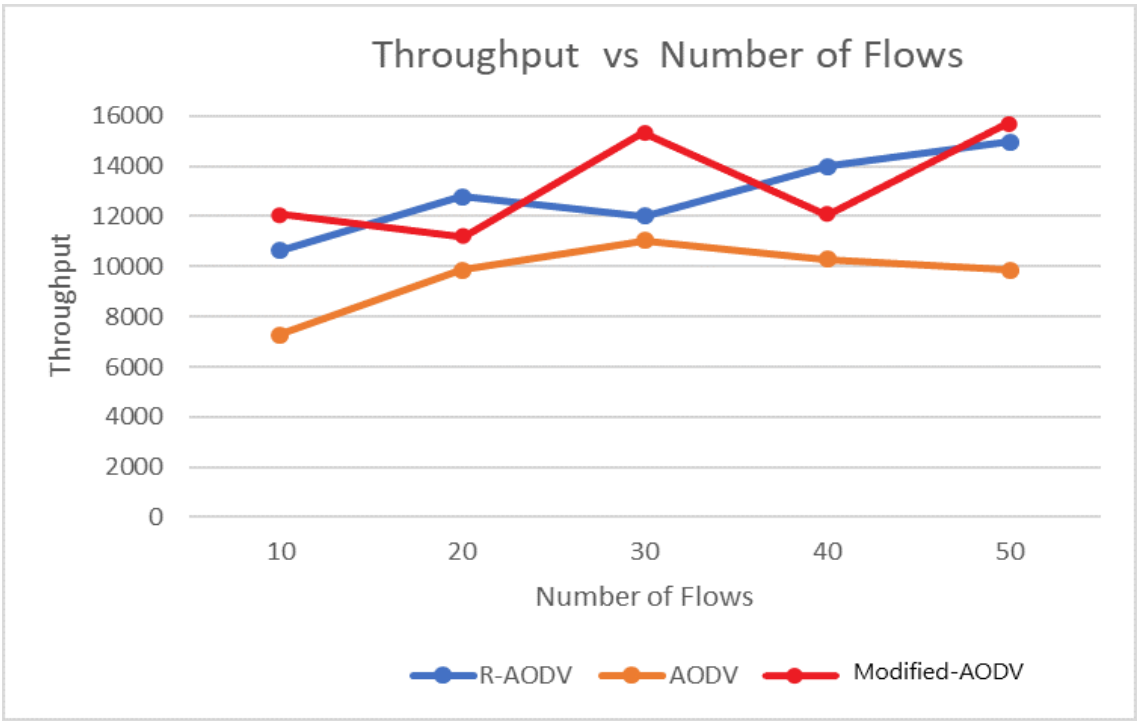


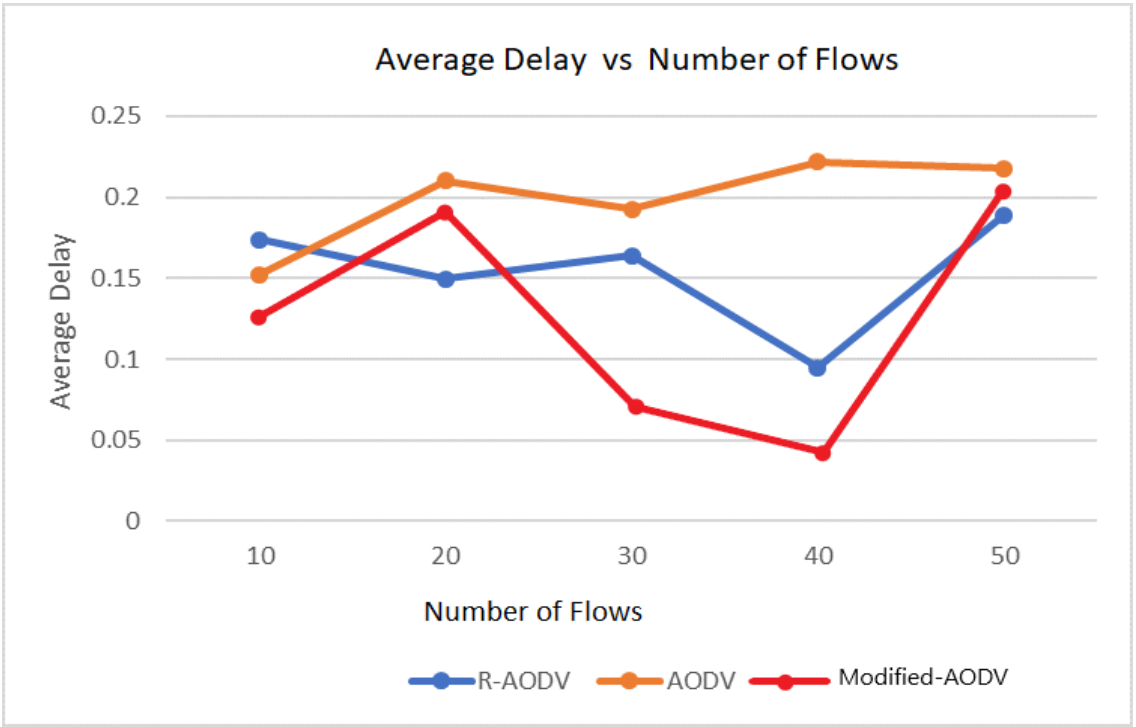
Varying Number of Flows :

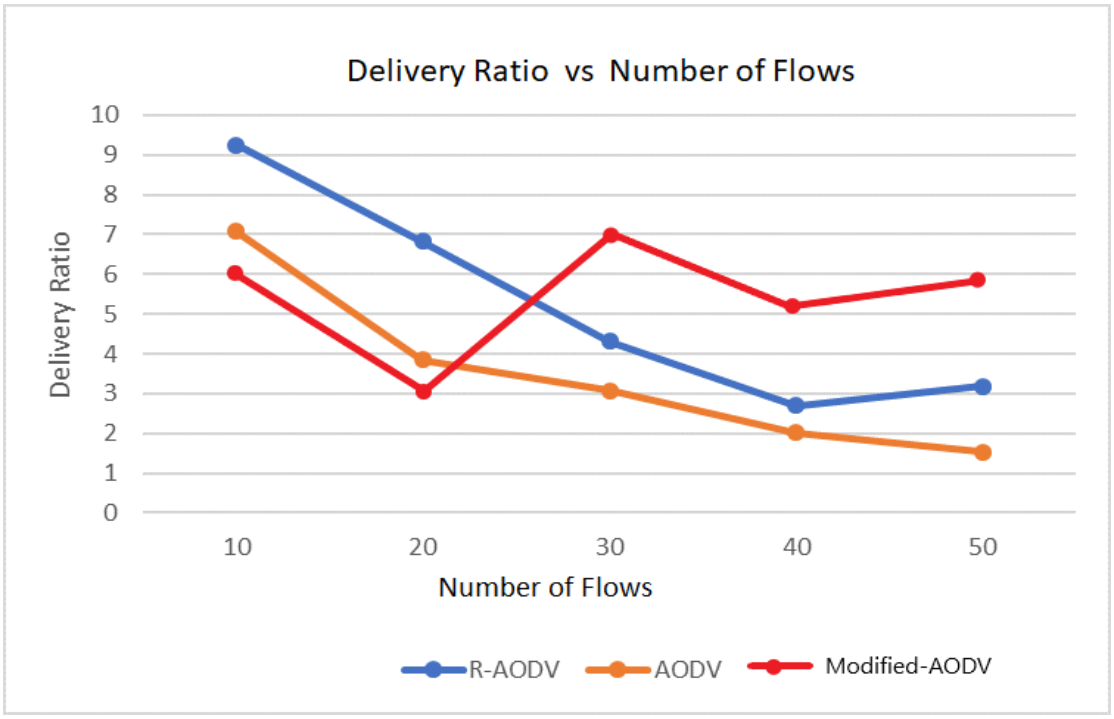
Number of Flows varied as 10, 20, 30, 40 and 50

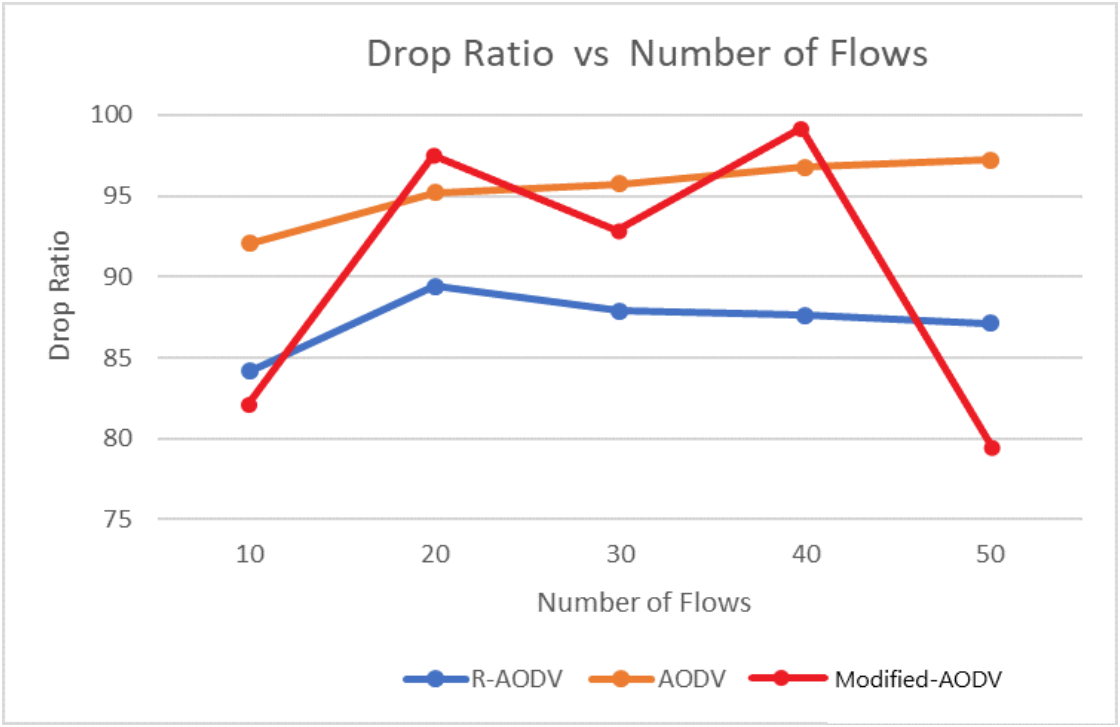
Baseline Parameters :

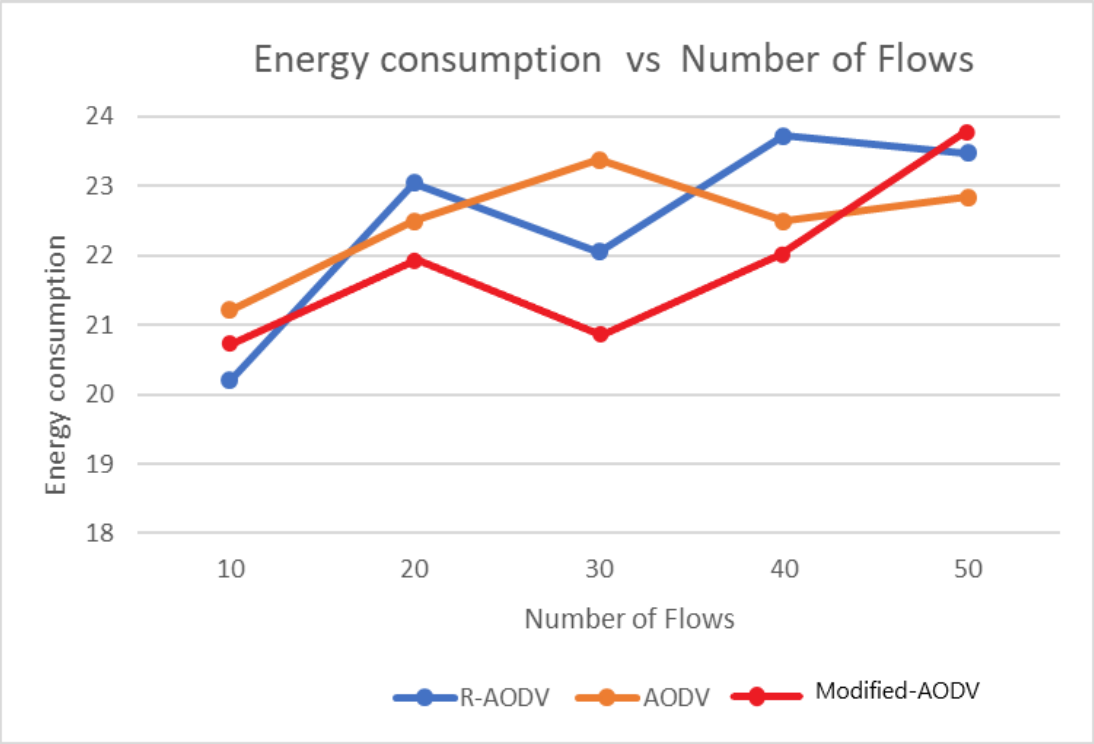
- Number of Nodes = 20
- Number of Packets per Second = 100
- Coverage Area = 80


Throughput vs Number of Flows
16000
14000
12000
10000
8000
6000
4000
2000
0
Throughput
10
20
30
40
50
Number of Flows
R-AODV
AODV
Modified-AODV


Average Delay vs Number of Flows
0.25
0.2
0.15
0.1
0.05
0
Average Delay
10
20
30
40
50
Number of Flows
R-AODV
AODV
Modified-AODV


Delivery Ratio vs Number of Flows
Delivery Ratio
10
9
8
7
6
5
4
3
2
1
0
10
20
30
40
50
Number of Flows
R-AODV
AODV
Modified-AODV


Drop Ratio vs Number of Flows
Drop Ratio
100
95
90
85
80
75
10
20
30
40
50
Number of Flows
R-AODV
AODV
Modified-AODV

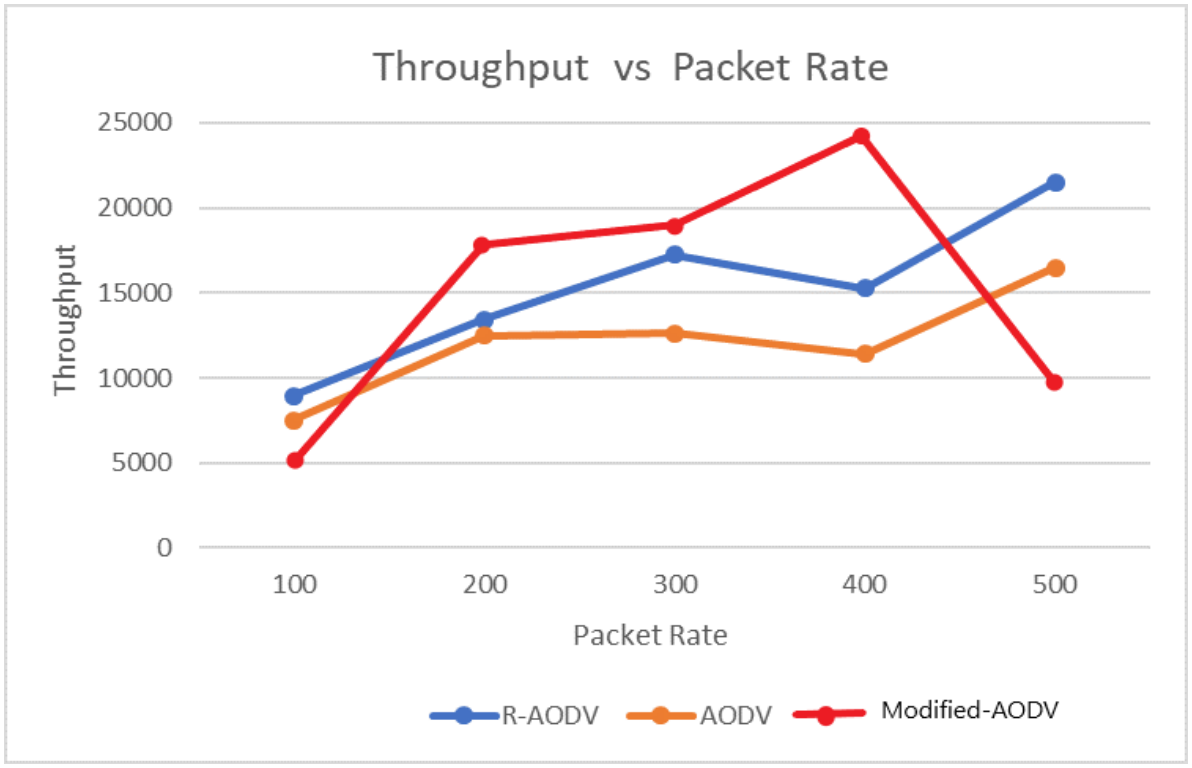


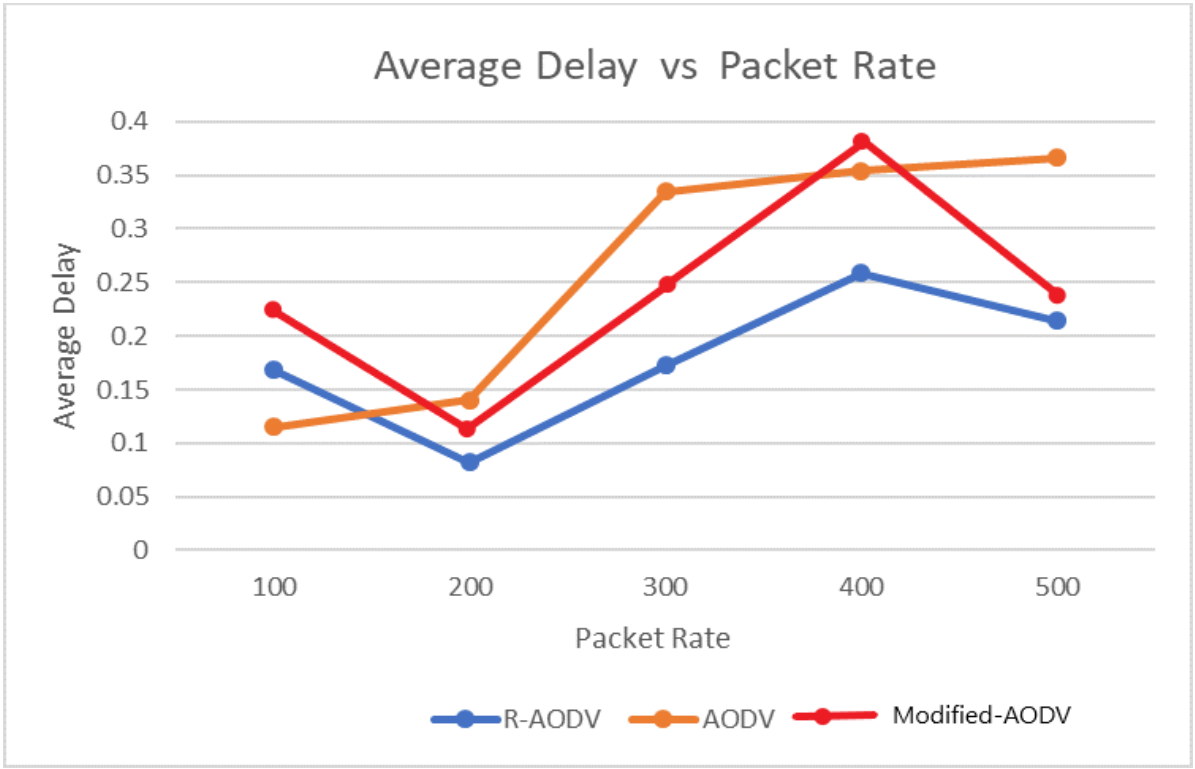
Varying Number of Packets per Second:

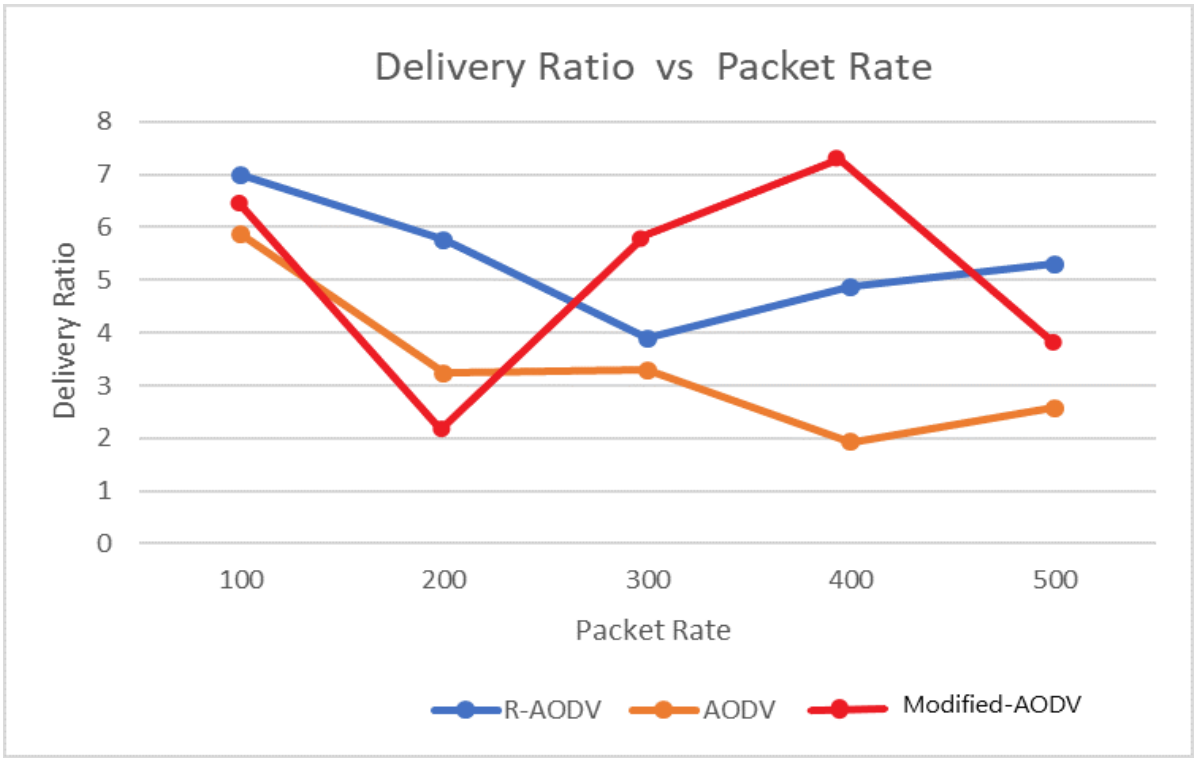
Number of packets per second varied as 100, 200, 300, 400 and 500

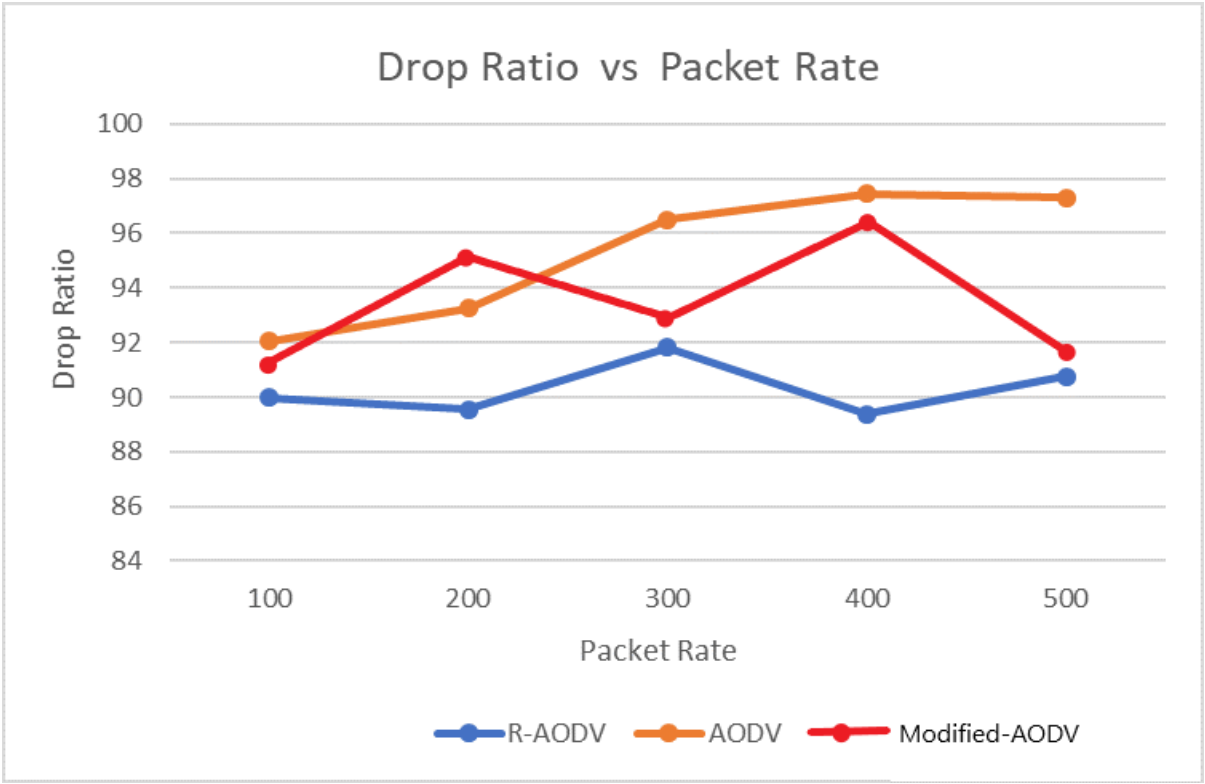
Baseline Parameters :

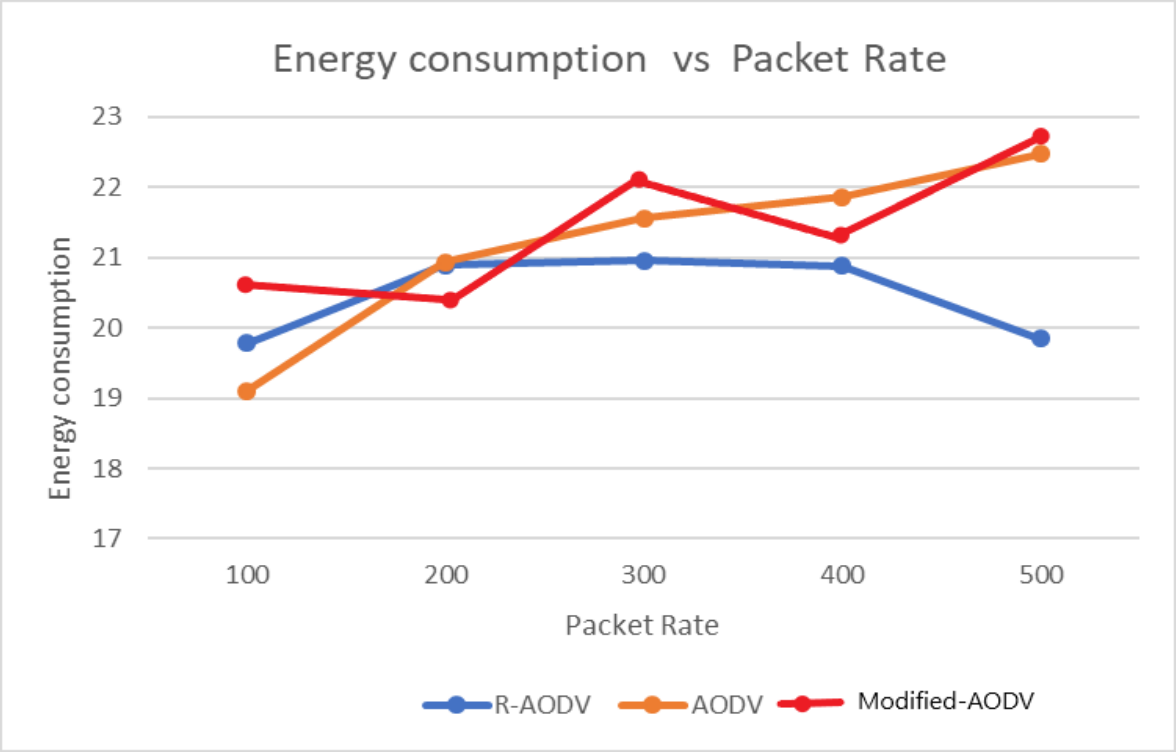
- Number of Nodes = 20
- Number of Nodes = 10
- Coverage Area = 80


Throughput vs Packet Rate
25000
20000
15000
10000
5000
0
Throughput
100
200
300
400
500
Packet Rate
R-AODV
AODV
Modified-AODV


Average Delay vs Packet Rate
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Average Delay
100
200
300
400
500
Packet Rate
R-AODV
AODV
Modified-AODV


Delivery Ratio vs Packet Rate
Delivery Ratio
8
7
6
5
4
3
2
1
0
100
200
300
400
500
Packet Rate
R-AODV
AODV
Modified-AODV


Drop Ratio vs Packet Rate
Drop Ratio
100
98
96
94
92
90
88
86
84
100
200
300
400
500
Packet Rate
R-AODV
AODV
Modified-AODV

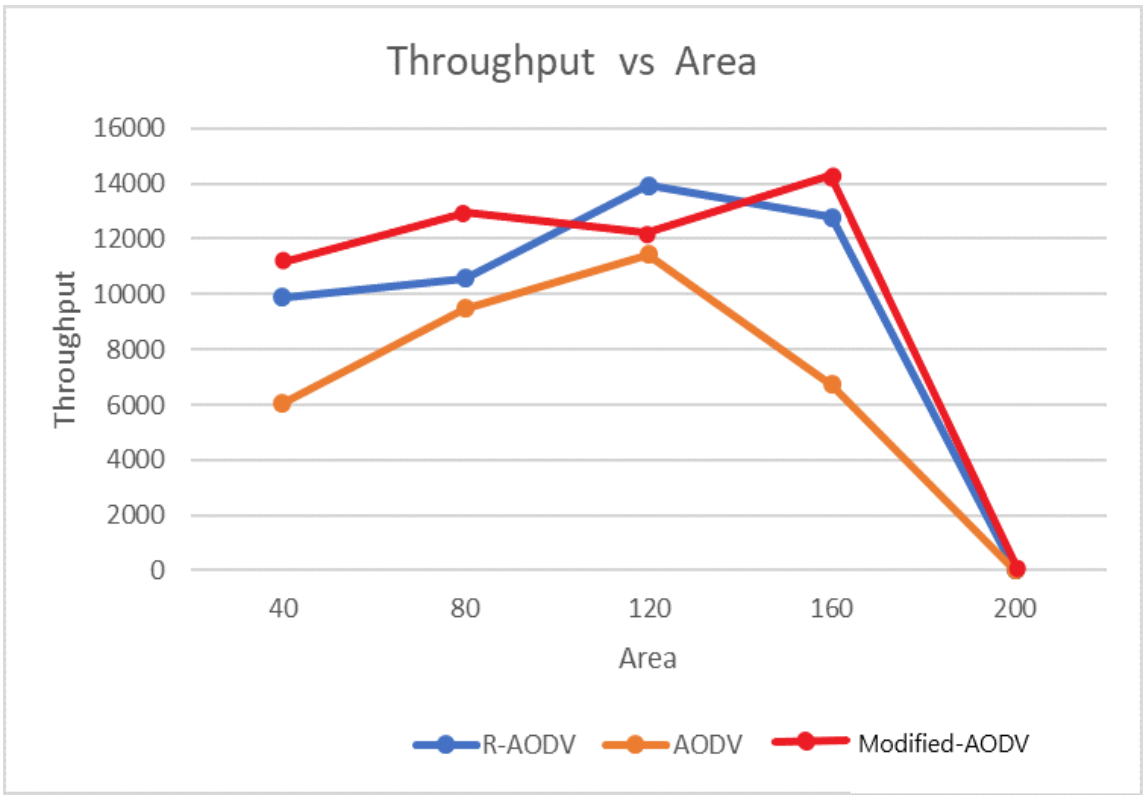


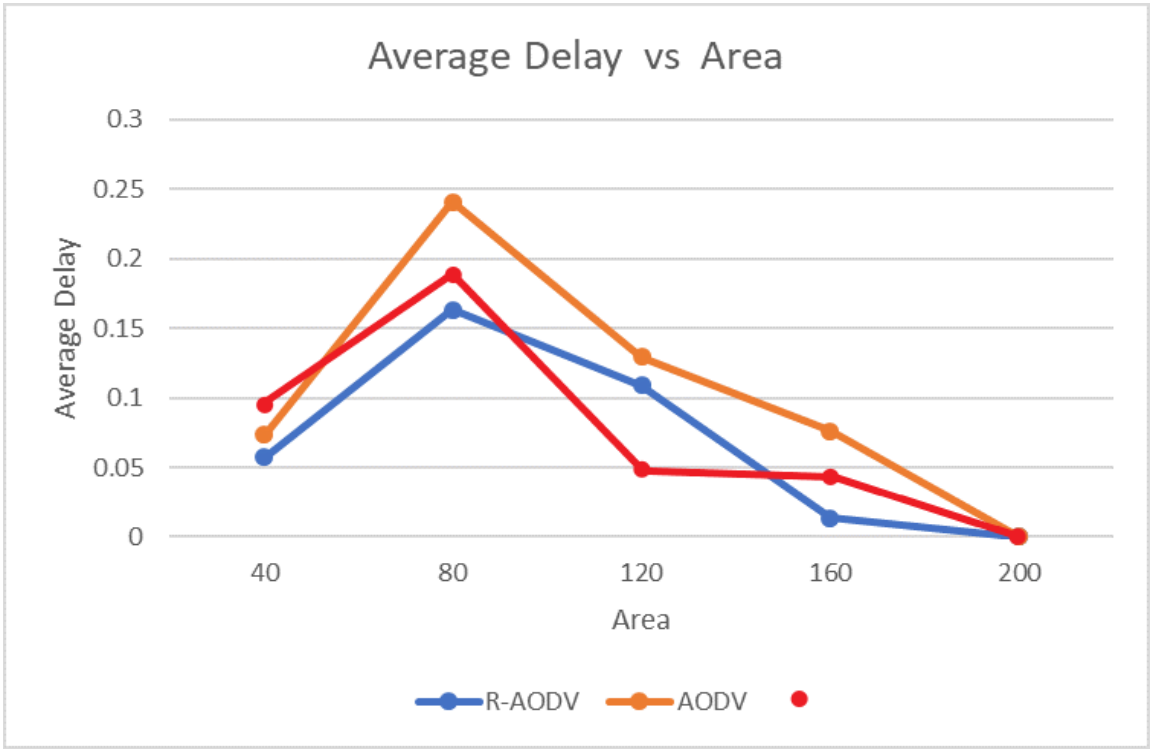
Varying Area Size :

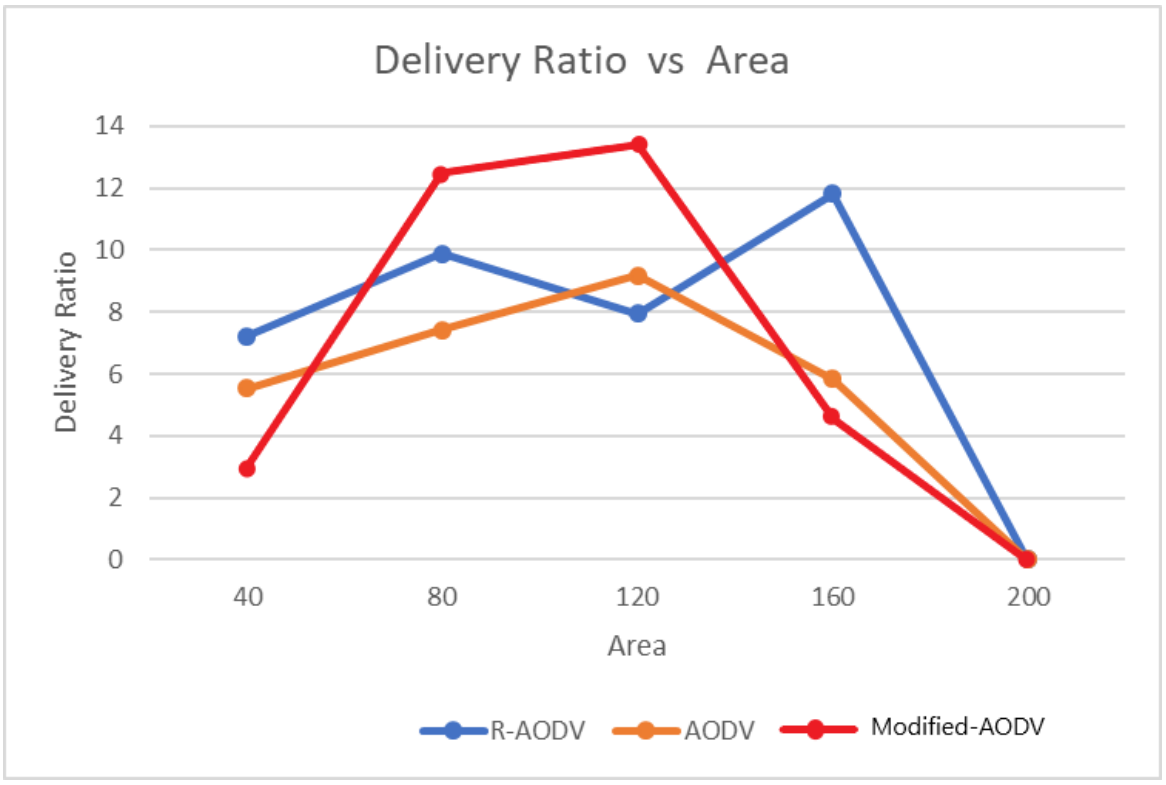
Coverage area varied as Tx_range, 2 x Tx_range, 3 x Tx_range, 4 x Tx_range and 5 x Tx_range (40, 80, 120, 160 and 200)

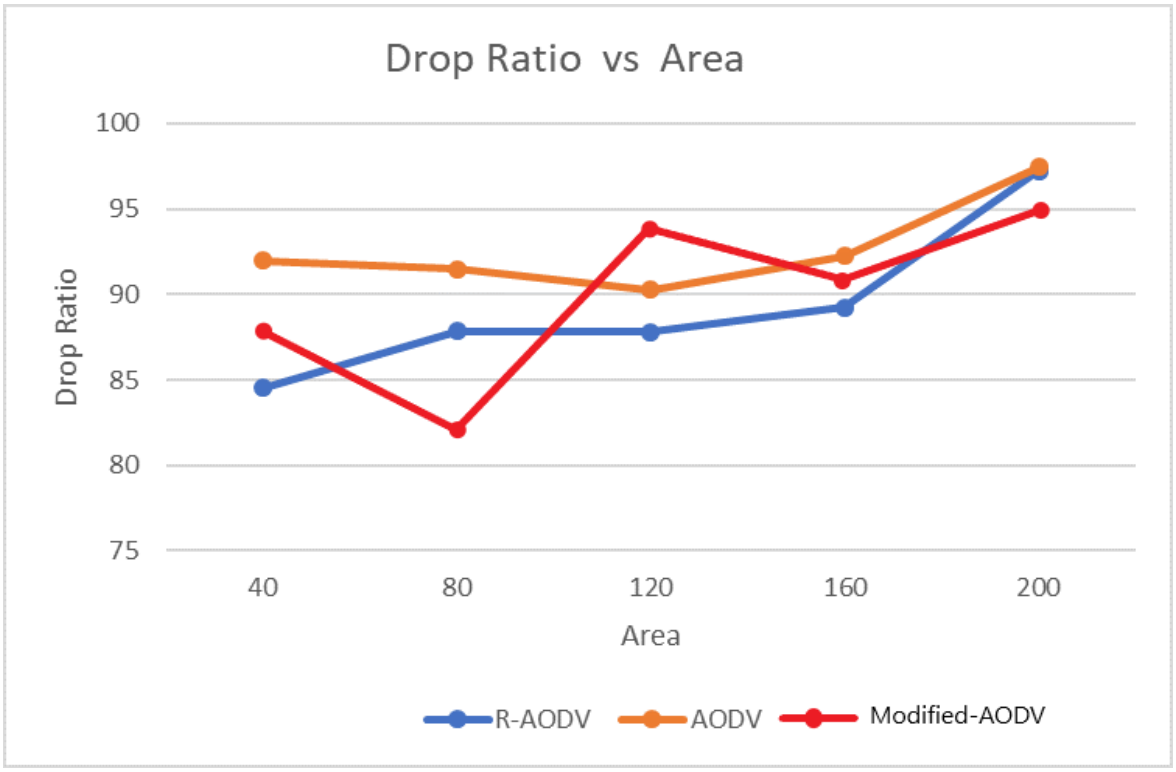
Baseline Parameters :

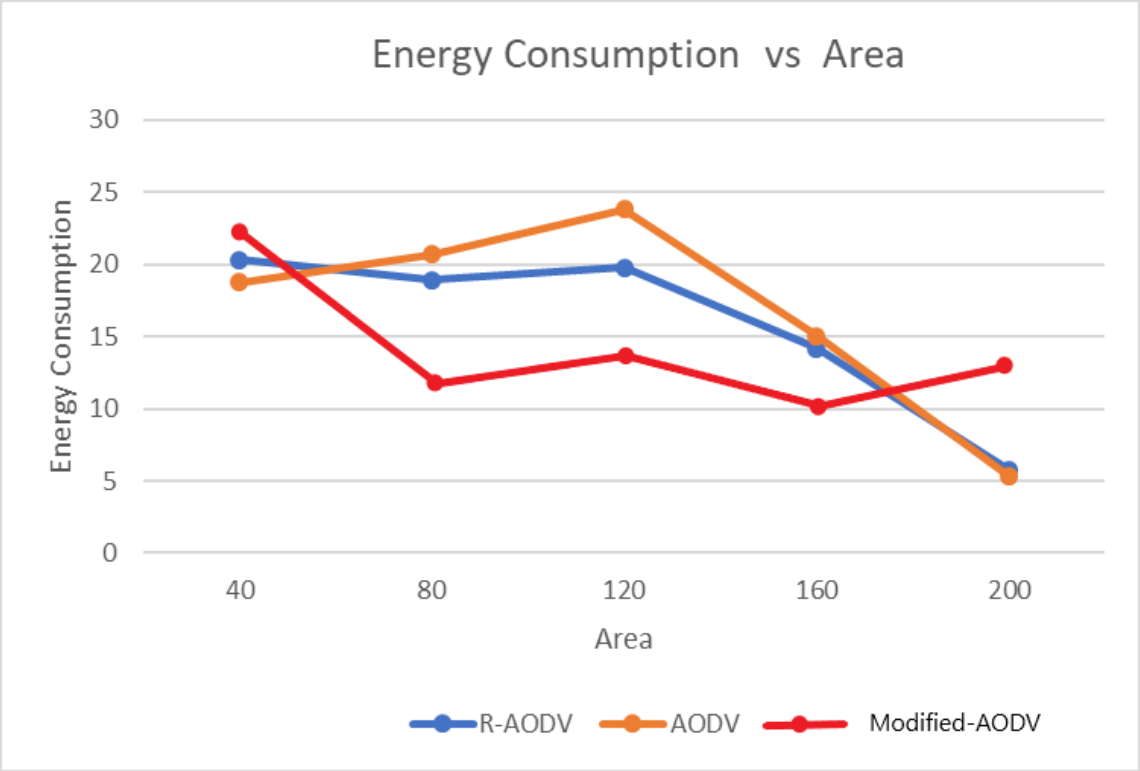
- Number of Nodes = 20
- Number of Flows = 10
- Number of Packets per Second = 100


Throughput vs Area
16000
14000
12000
10000
8000
6000
4000
2000
0
Throughput
40
80
120
160
200
Area
R-AODV
AODV
Modified-AODV


Average Delay vs Area
0.3
0.25
0.2
0.15
0.1
0.05
0
Average Delay
40
80
120
160
200
Area
R-AODV
AODV


Delivery Ratio vs Area
Delivery Ratio
14
12
10
8
6
4
2
0
40
80
120
160
200
Area
R-AODV
AODV
Modified-AODV


Drop Ratio vs Area
Drop Ratio
100
95
90
85
80
75
40
80
120
160
200
Area
R-AODV
AODV
Modified-AODV



Graphs for Wireless 802.11 Static Network :

For wireless 802.11 static network simulation, I have used CBR in application layer (cbr_size 1000 and cbr_rate 11.0 Mb) and UDP in transport layer. High cbr rate and size used for better simulation result.

- Channel: Wireless channel
- Propagation: Two-ray ground
- Antenna: Omnidirectional
- Link: IEEE 802.11
- Queue: Drop-tail
- Routing: AODV
- Maximum packets in interface queue : 100
- Position: Grid
- Flow: Random source to random destination

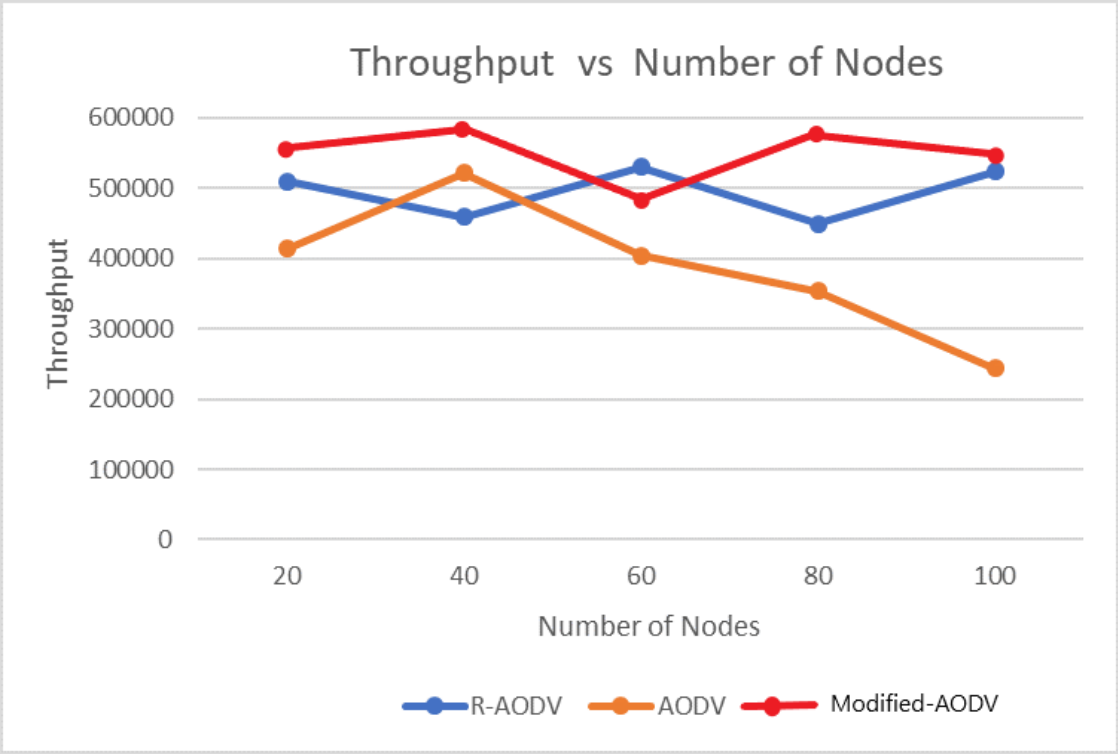
- Number of nodes: Variable
- Number of flows: Variable
- Number of packets per seconds: Variable
- Coverage area: Variable

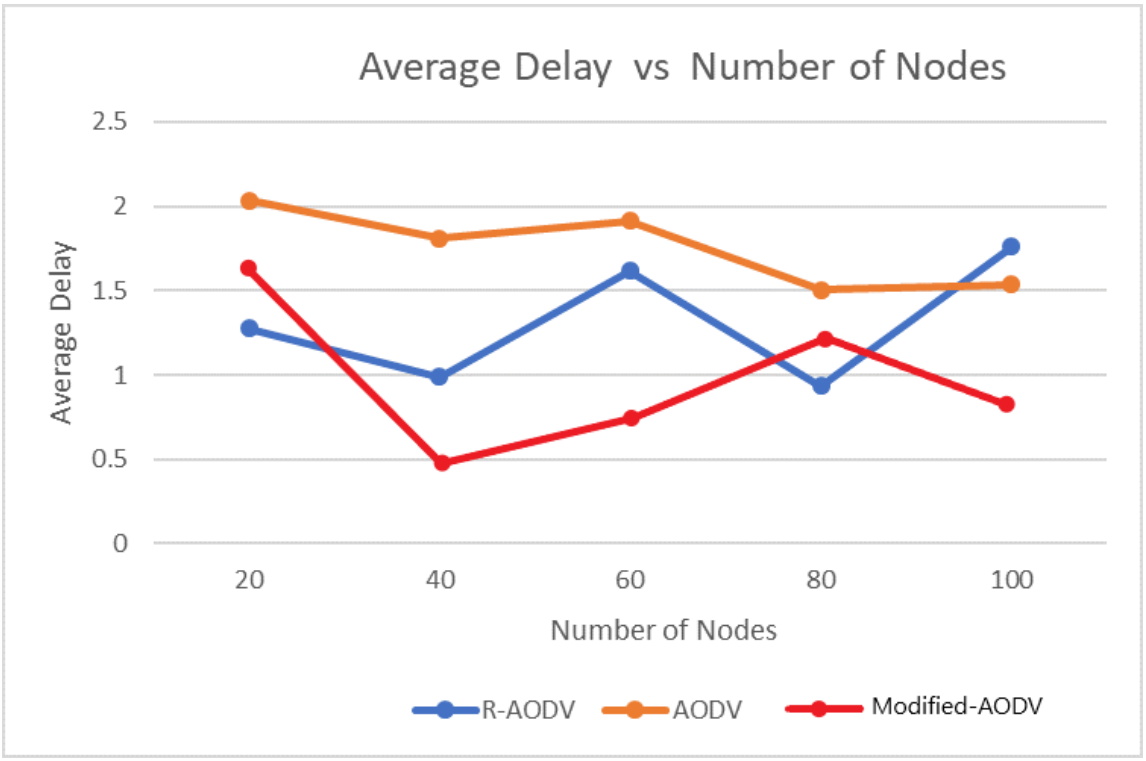
Varying Number of Nodes:

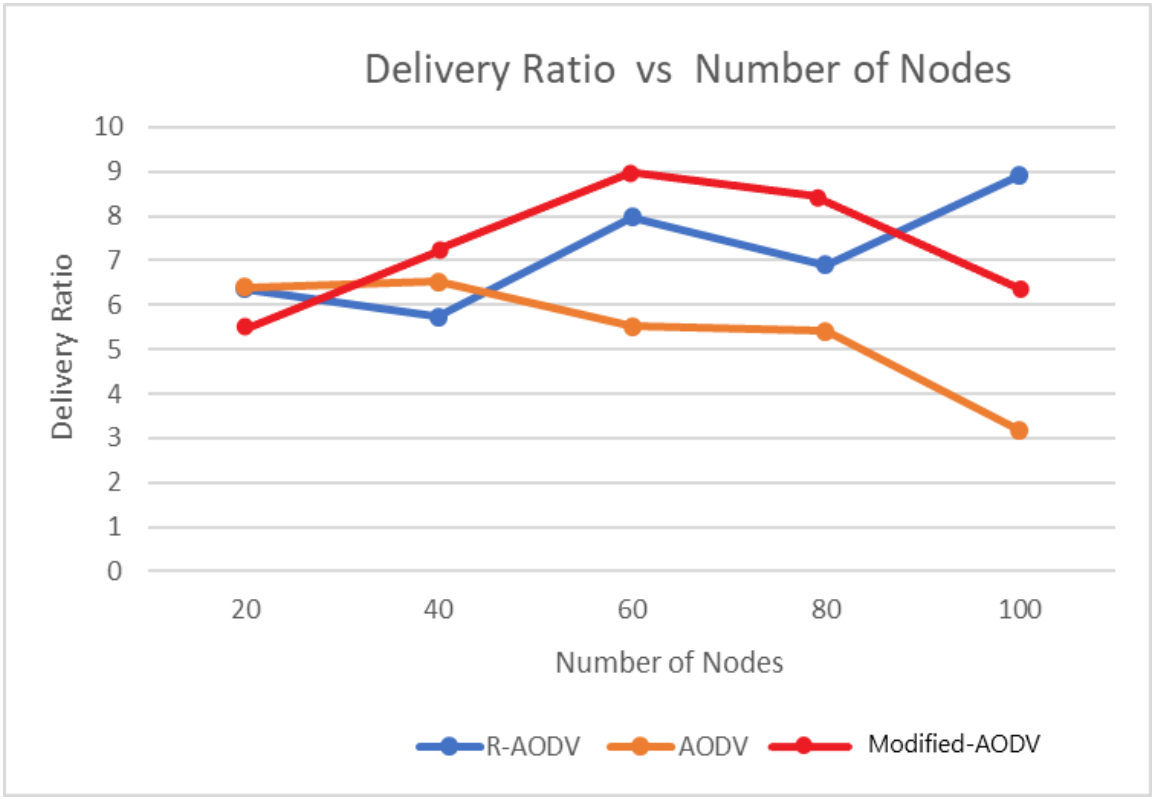
Number of Nodes varied as 20, 40, 60, 80 and 100

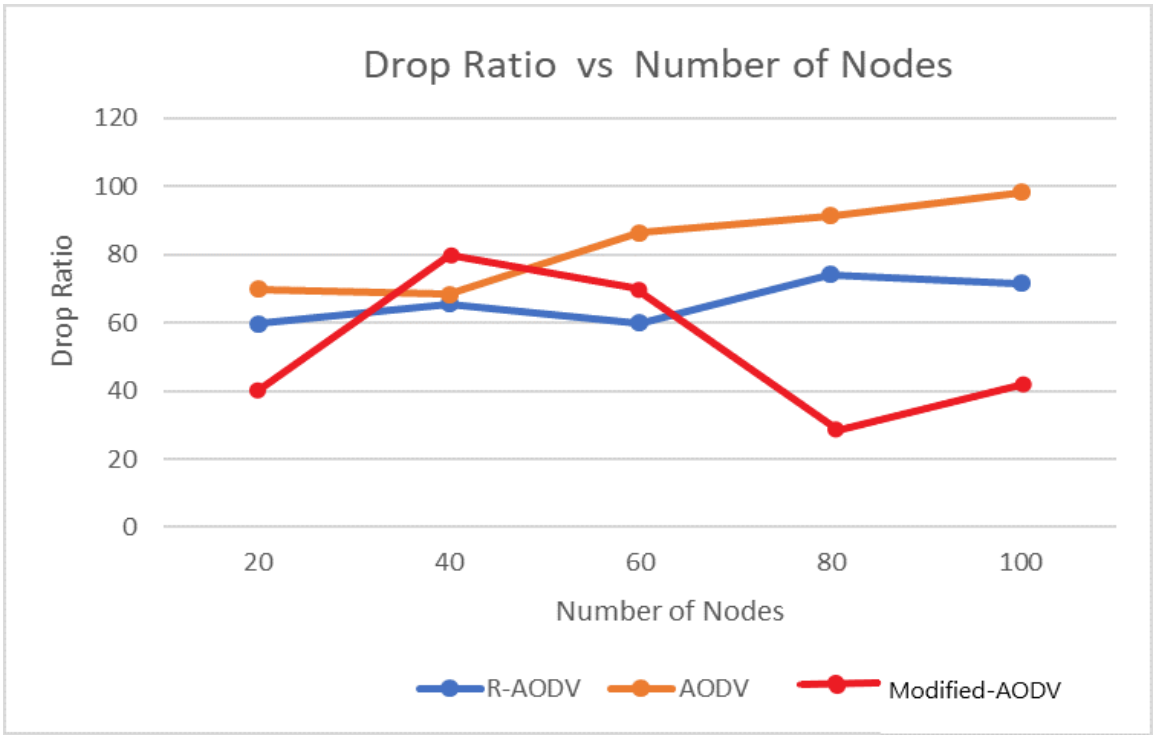
Baseline Parameters :

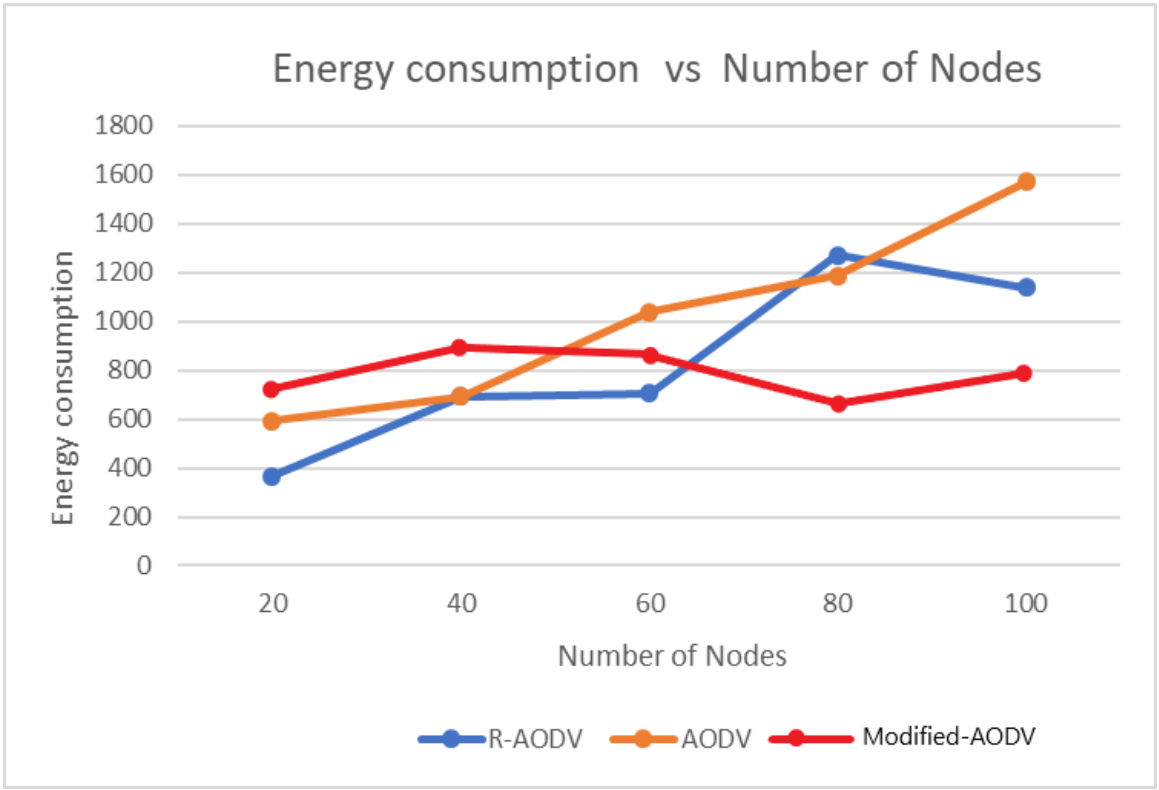
- Number of Flows = 10
- Number of Packets per Second = 100
- Coverage Area = 80




Average Delay vs Number of Nodes
2.5
2
1.5
1
0.5
0
Average Delay
20
40
60
80
100
Number of Nodes
R-AODV
AODV
Modified-AODV


Delivery Ratio vs Number of Nodes
10
9
8
7
6
5
4
3
2
1
0
Delivery Ratio
20
40
60
80
100
Number of Nodes
R-AODV
AODV
Modified-AODV


Drop Ratio vs Number of Nodes
120
100
80
60
40
20
0
Drop Ratio
20
40
60
80
100
Number of Nodes
R-AODV
AODV
Modified-AODV

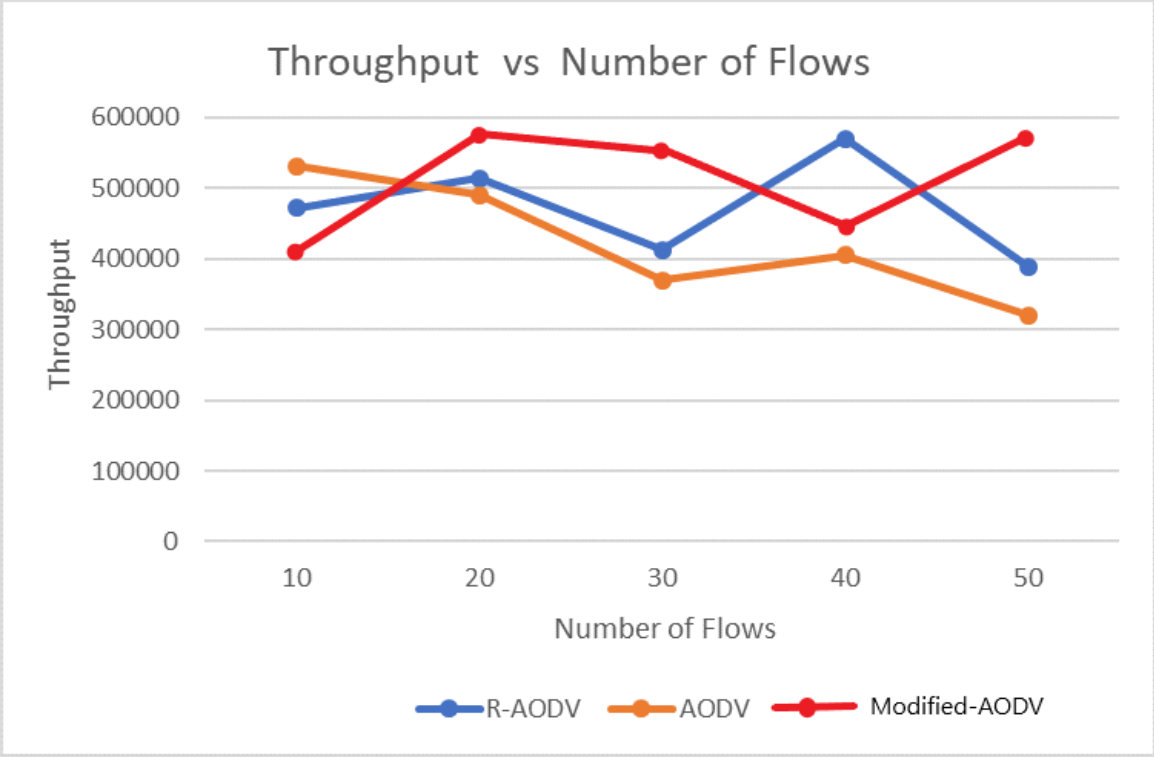

Energy consumption vs Number of Nodes
1800
1600
1400
1200
1000
800
600
400
200
0
Energy consumption
20
40
60
80
100
Number of Nodes
R-AODV
AODV
Modified-AODV

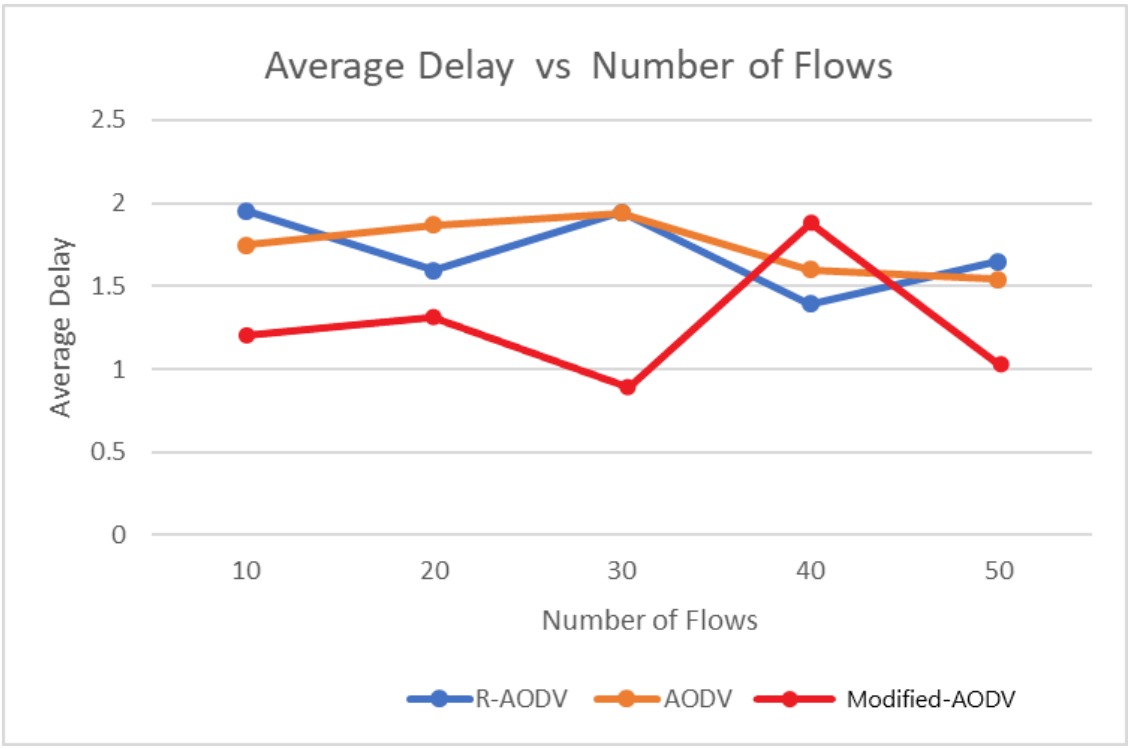
Varying Number of Flows:

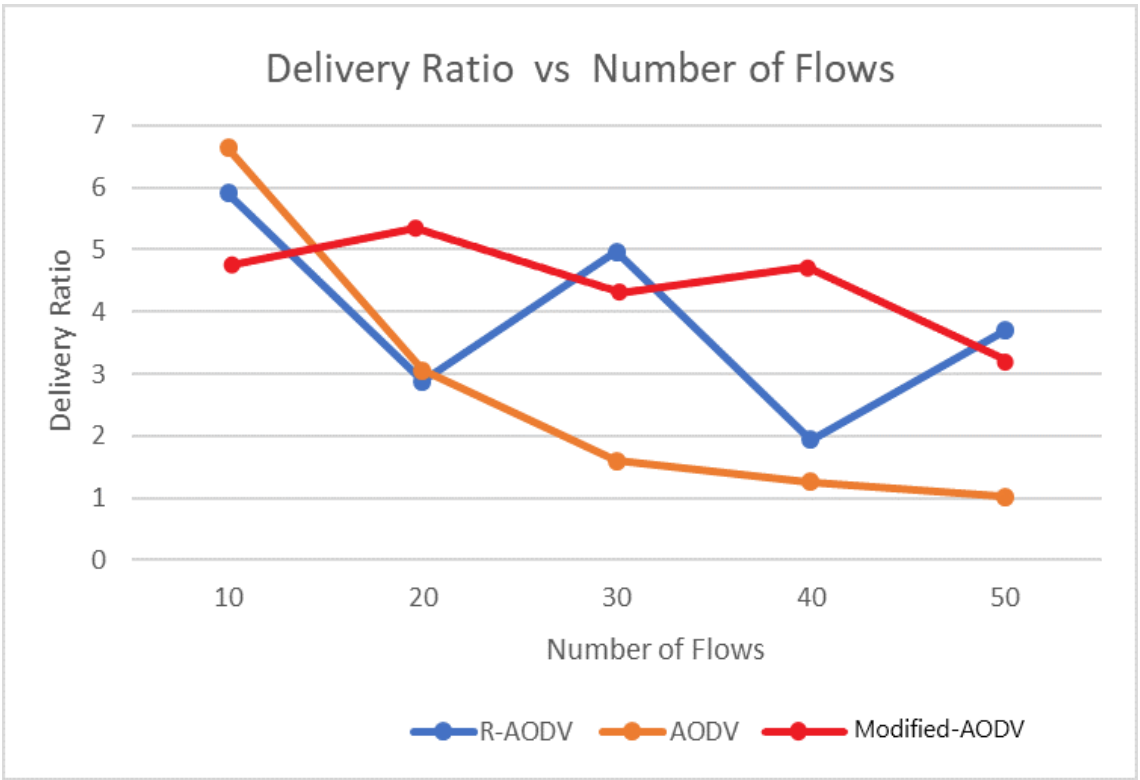
Number of Flows varied as 10, 20, 30, 40 and 50

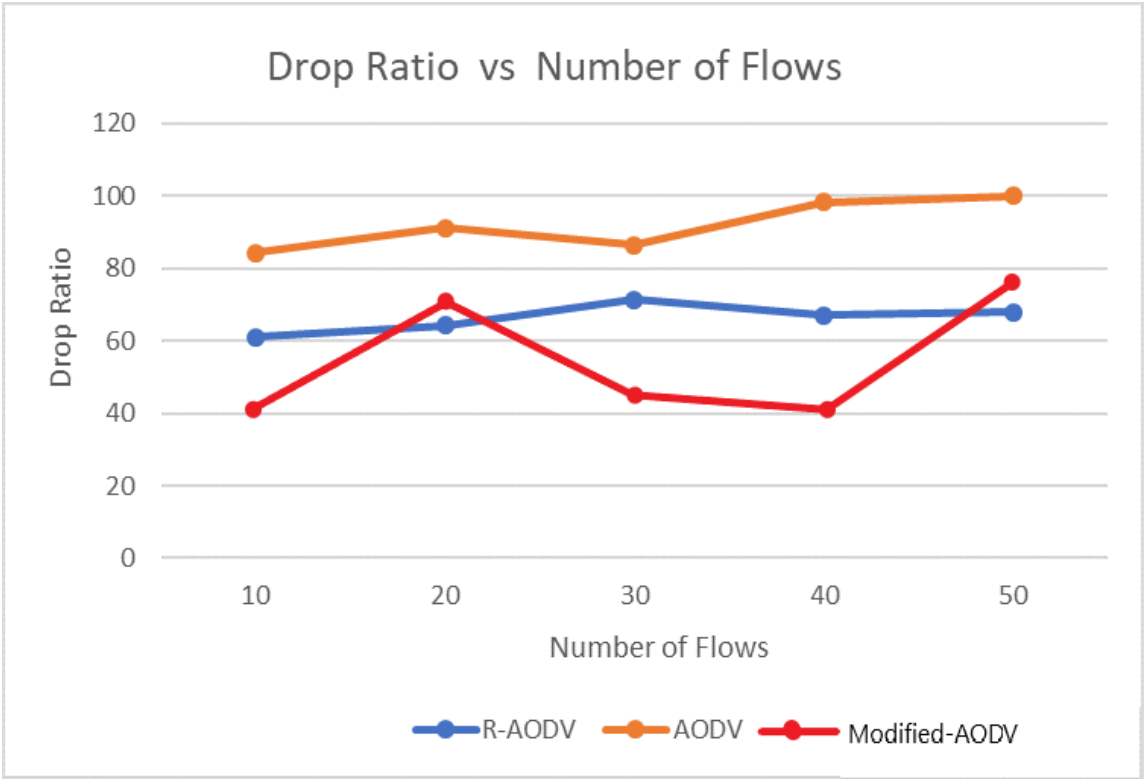
Baseline Parameters :

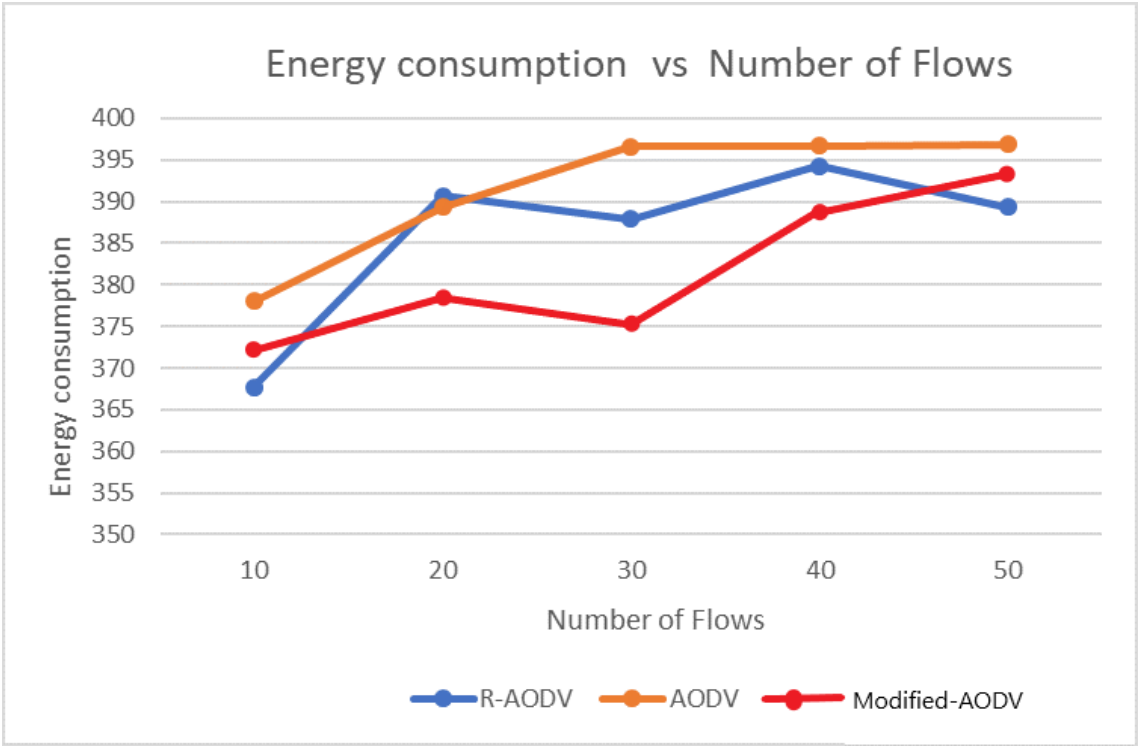
- Number of Nodes = 20
- Number of Packets per Second = 100
- Coverage Area = 80




Average Delay vs Number of Flows
2.5
2
1.5
1
0.5
0
Average Delay
10
20
30
40
50
Number of Flows
R-AODV
AODV
Modified-AODV


Delivery Ratio vs Number of Flows
7
6
5
4
3
2
1
0
Delivery Ratio
10
20
30
40
50
Number of Flows
R-AODV
AODV
Modified-AODV


Drop Ratio vs Number of Flows
120
100
80
60
40
20
0
Drop Ratio
10
20
30
40
50
Number of Flows
R-AODV
AODV
Modified-AODV

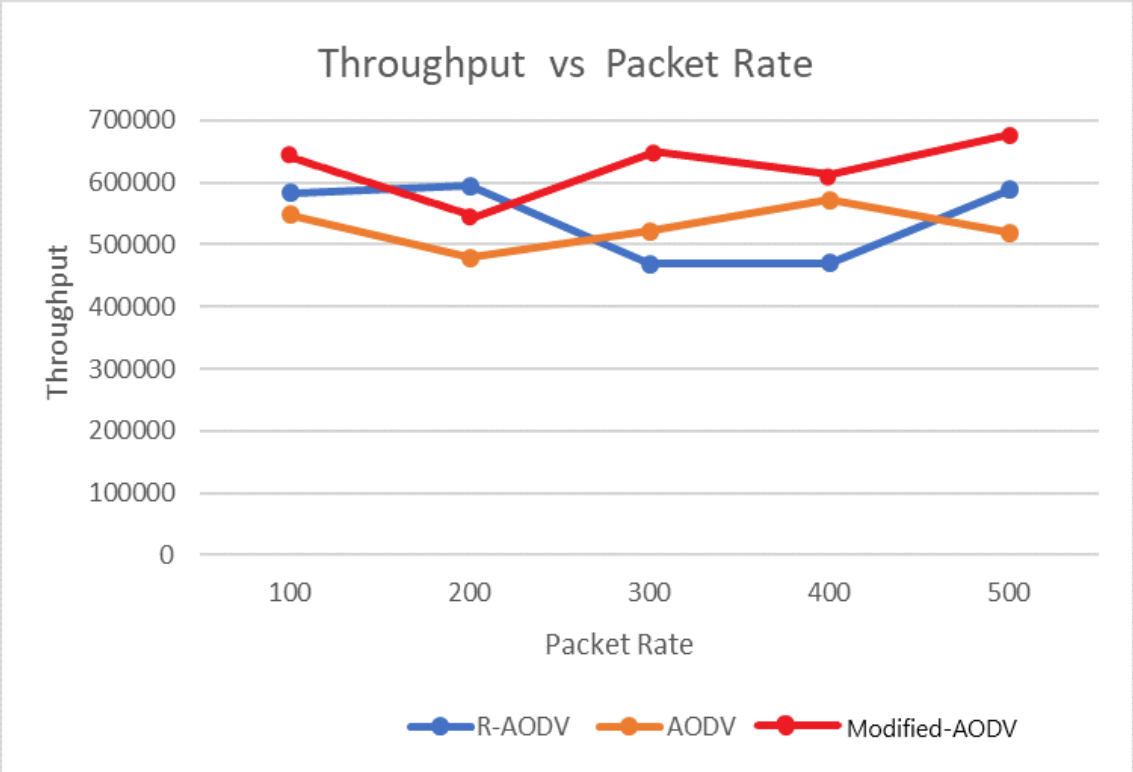

Energy consumption vs Number of Flows
400
395
390
385
380
375
370
365
360
355
350
Energy consumption
10
20
30
40
50
Number of Flows
R-AODV
AODV
Modified-AODV

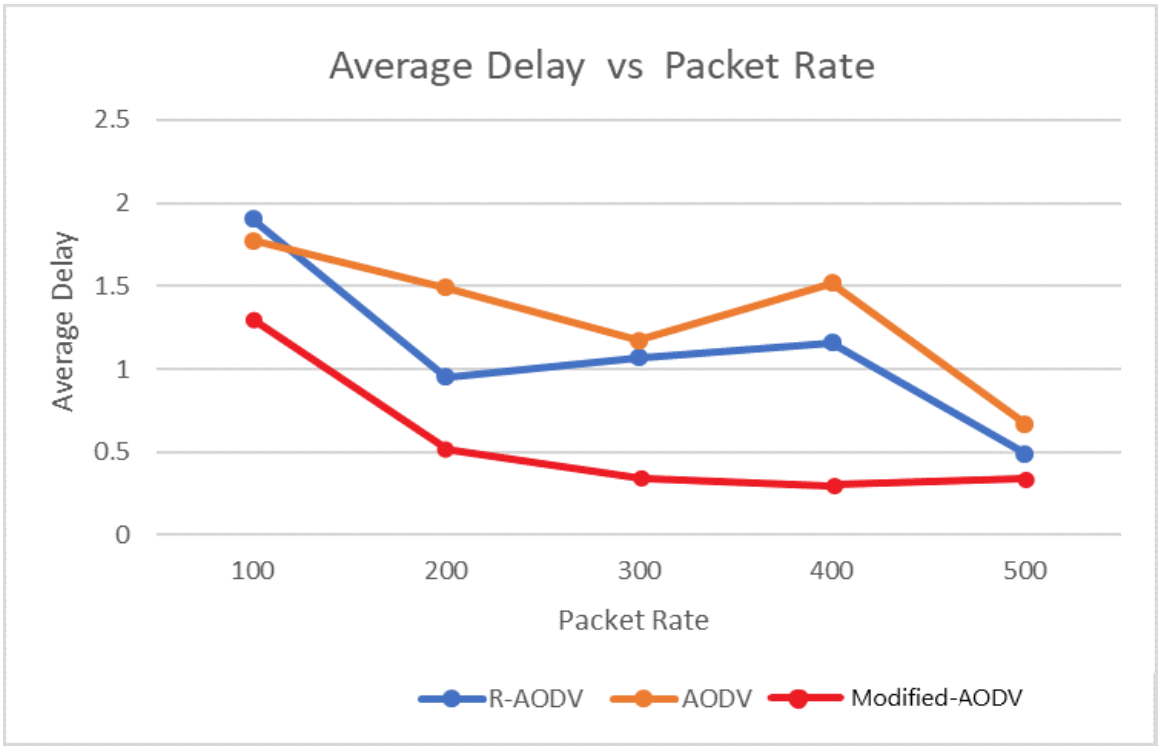
Varying Number of Packets per Second :

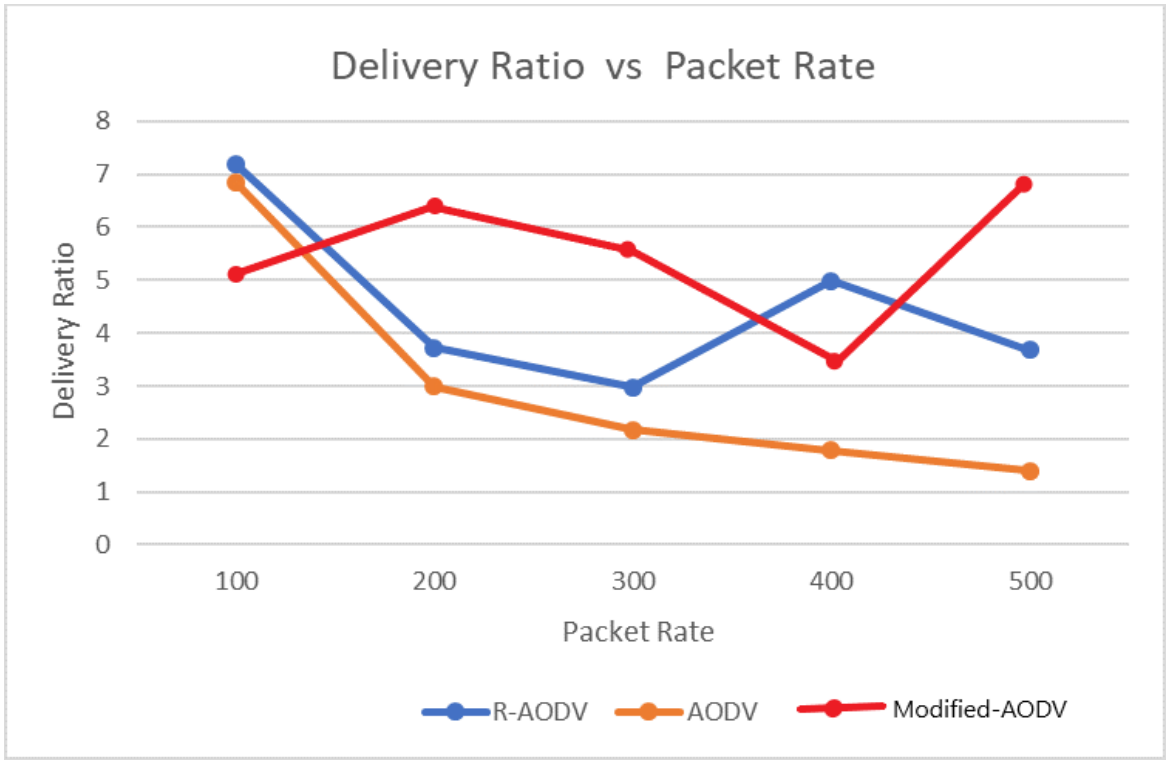
Number of packets per second varied as 100, 200, 300, 400 and 500

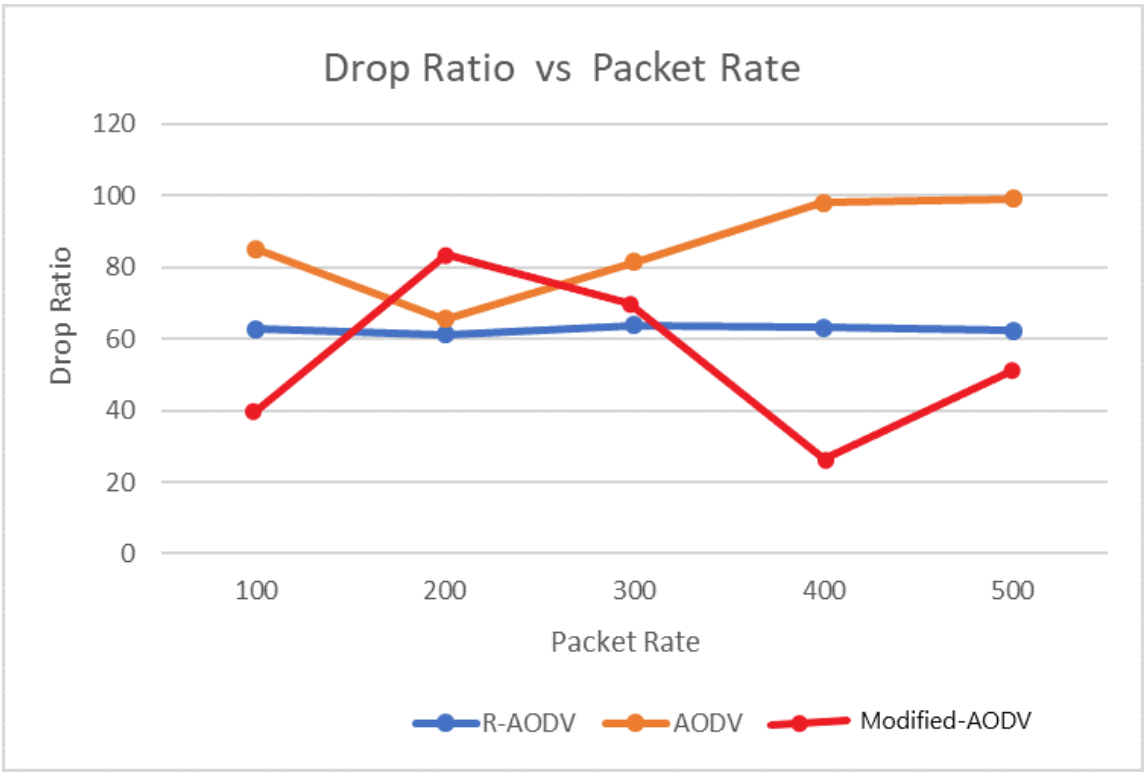
Baseline Parameters :

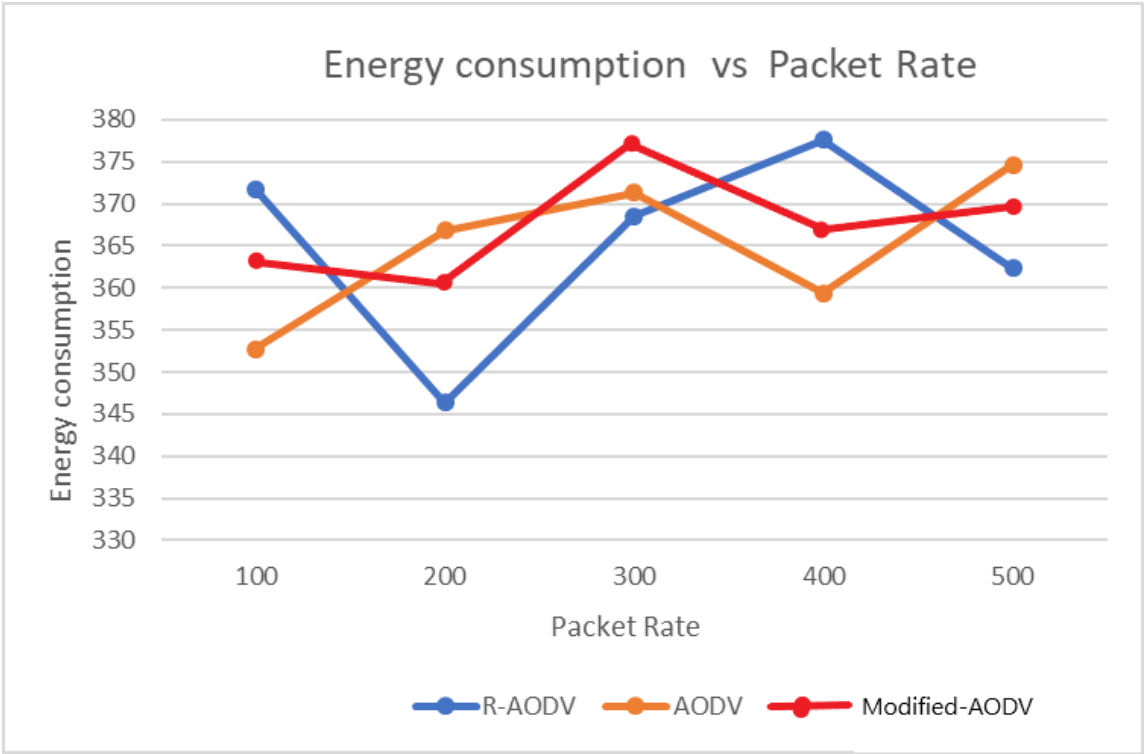
- Number of Nodes = 20
- Number of Nodes = 10
- Coverage Area = 80




Average Delay vs Packet Rate
2.5
2
1.5
1
0.5
0
Average Delay
100
200
300
400
500
Packet Rate
R-AODV
AODV
Modified-AODV


Delivery Ratio vs Packet Rate
8
7
6
5
4
3
2
1
0
Delivery Ratio
100
200
300
400
500
Packet Rate
R-AODV
AODV
Modified-AODV


Drop Ratio vs Packet Rate
120
100
80
60
40
20
0
Drop Ratio
100
200
300
400
500
Packet Rate
R-AODV
AODV
Modified-AODV

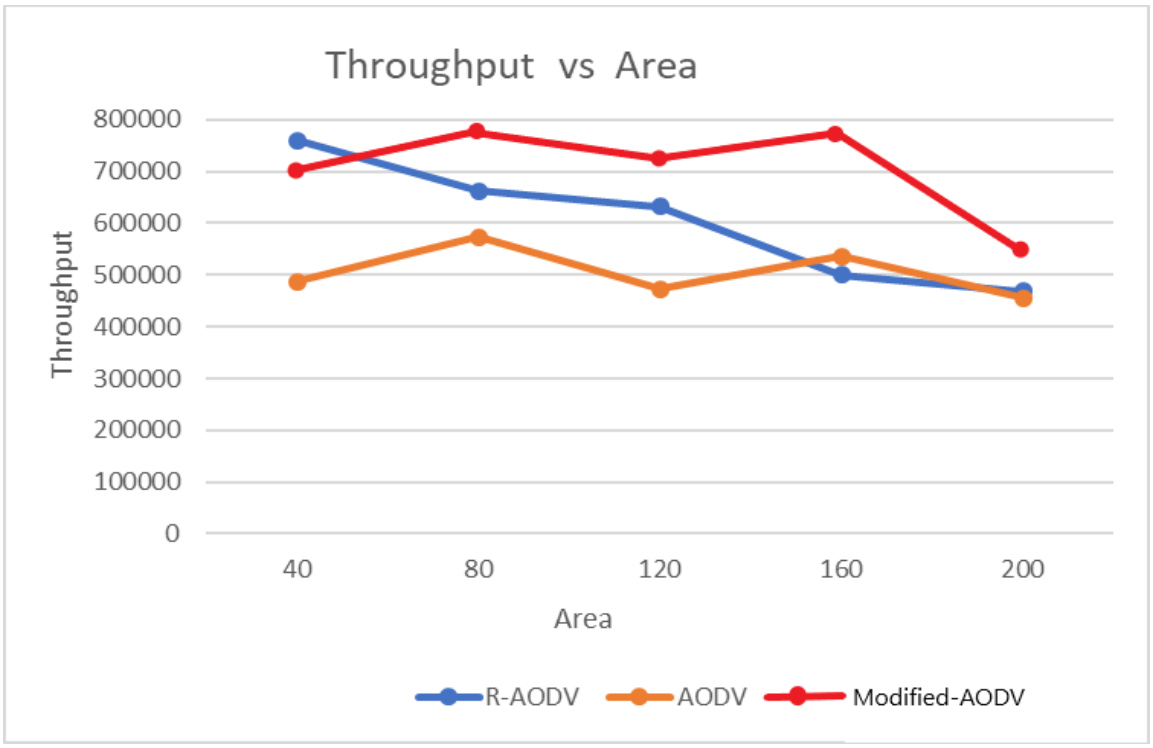

Energy consumption vs Packet Rate
380
375
370
365
360
355
350
345
340
335
330
Energy consumption
100
200
300
400
500
Packet Rate
R-AODV
AODV
Modified-AODV

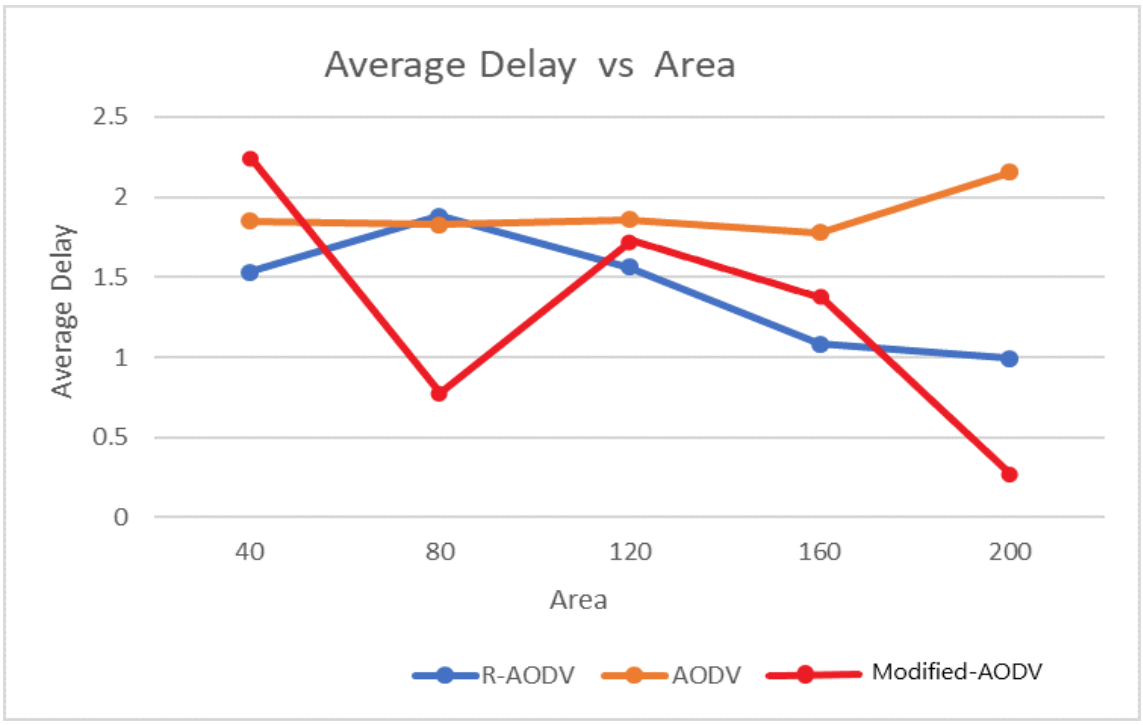
Varying Area Size :

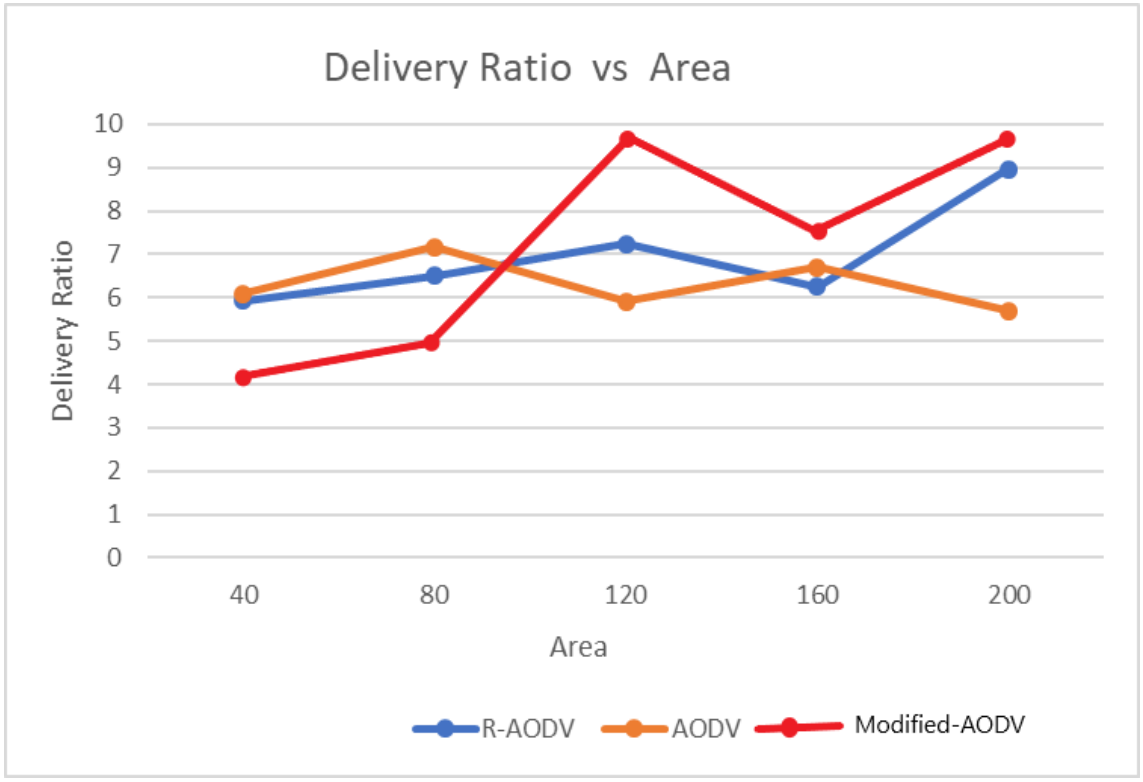
Coverage area varied as Tx_range, 2 x Tx_range, 3 x Tx_range, 4 x Tx_range and 5 x Tx_range (40, 80, 120, 160 and 200)

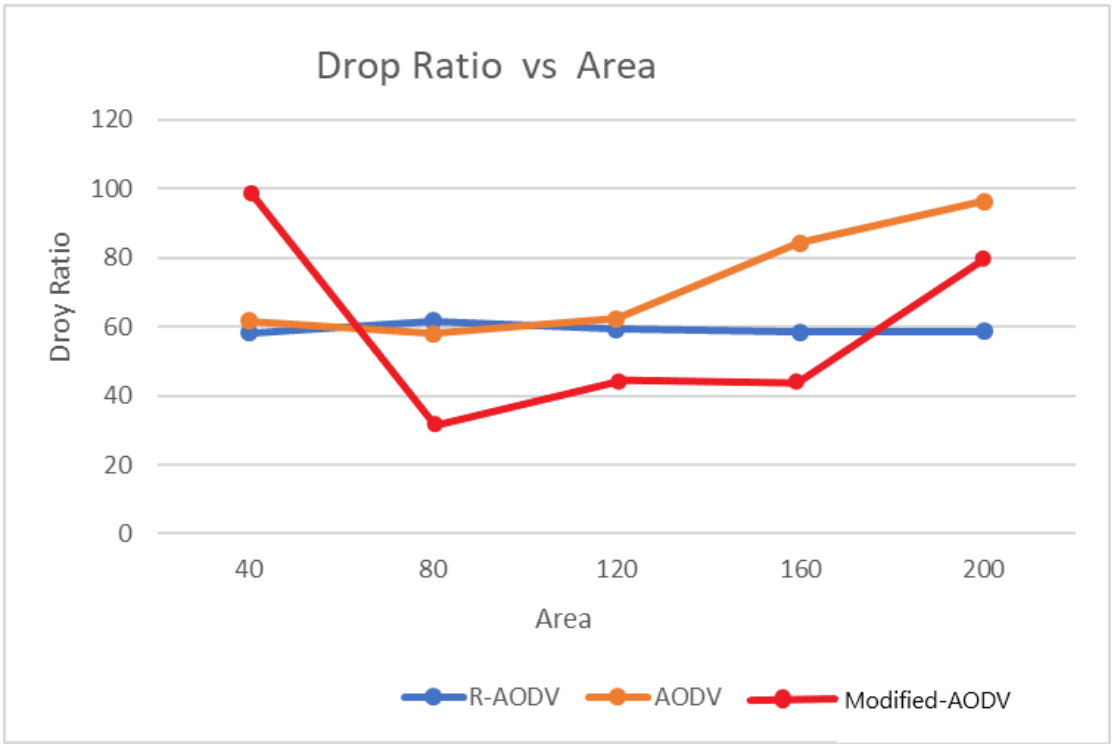
Baseline Parameters :

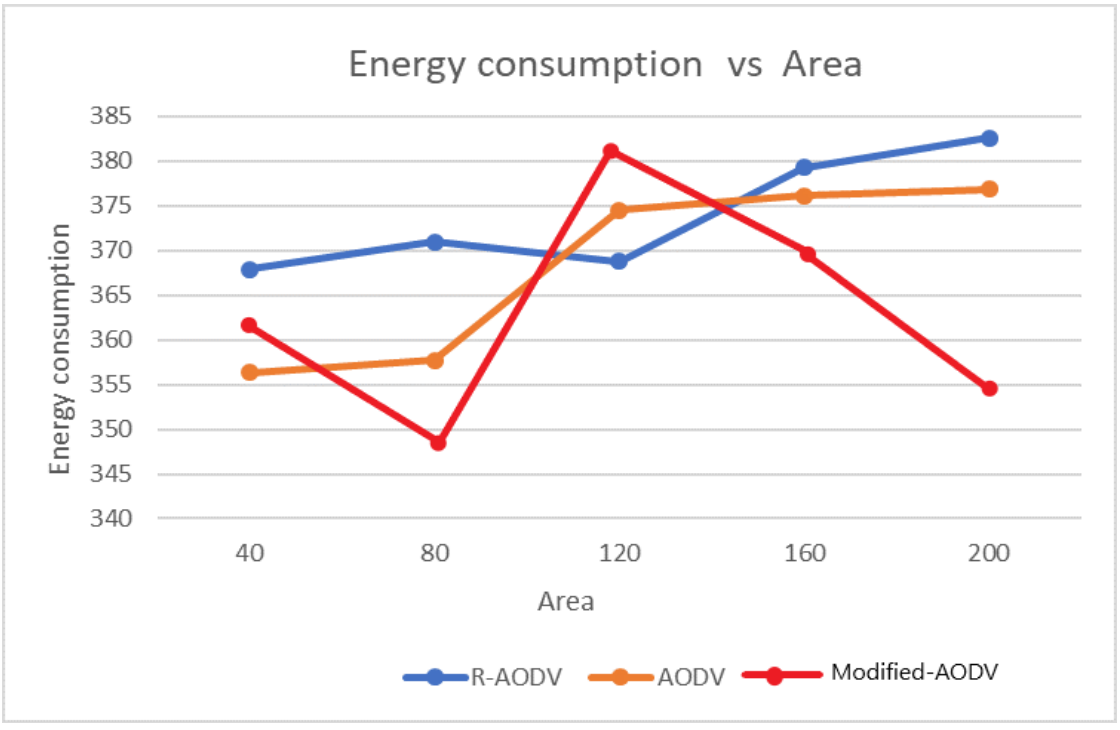
- Number of Nodes = 20
- Number of Flows = 10
- Number of Packets per Second = 100




Average Delay vs Area
Average Delay
2.5
2
1.5
1
0.5
0
40
80
120
160
200
Area
R-AODV
AODV
Modified-AODV


Delivery Ratio vs Area
Delivery Ratio
10
9
8
7
6
5
4
3
2
1
0
40
80
120
160
200
Area
R-AODV
AODV
Modified-AODV


Drop Ratio vs Area
Droy Ratio
120
100
80
60
40
20
0
40
80
120
160
200
Area
R-AODV
AODV
Modified-AODV


Energy consumption vs Area
Energy consumption
385
380
375
370
365
360
355
350
345
340
40
80
120
160
200
Area
R-AODV
AODV
Modified-AODV

Observations :

In very big topology, basic AODV doesn't perform well because of large number of communication and huge number of redundant packets. Here congestion occurs because of increasing number of redundant RREQ packets. The modified approach performed better almost in every case, as shown comparison in graphs. In some case, it has improved throughput and delivery ratio significantly and also decreased the drop ratio as well as average end-to-end delay. The modified approach is also energy conservative. But for small number of nodes and flows, we see that modified approach performs almost same as the basic AODV in some cases. In all the other cases, it has performed better and significantly improved all the performance metrics.