Analysis of AODV Protocol in MANET

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ABSTRACT
The Ad-Hoc on demand distance vector (AODV) routing protocol to be used by mobile nodes in an ad hoc network. It offers fast adaptation to dynamic link conditions, low process and memory overhead, low network utilization and determines unicast routes destinations inside the ad hoc network. It uses destination sequence numbers to confirm loop freedom in any respect of times (even within the face of abnormal delivery of routing management messages), avoiding issues (such as "continuity to infinity") related to classical distance vector protocols. Ad-Hoc networking could be a thought in pc communications characterized by property through a set of wireless nodes and fast changing network topology. In a wireless scenario, nodes are free to move hence maintaining path (route) is a difficult task. Routing protocols have central role in a wireless scenario. We have analyzed AODV protocol by extensive simulations in ns-2 simulator with various performance matrices such as Throughput, Number of packets sent, Number of packets received, Packets delivery ratio, Control overhead, Packet dropping ratio, Delay, Normalized routing overhead under wireless scenarios varying speed. And with this we are also trying to detect the Black Hole Attack in AODV.

General Terms
Ad Hoc Networking.

Keywords
AODV, MANET, ns-2 simulator, Packet delivery fraction, Throughput, Number of packets sent, Number of packets received, Packet delivery ratio, Control over head, Packet dropping ratio, Delay, Normalized routing overhead.

1. INTRODUCTION

1.1 MANET
MANET stands for Mobile adhoc Network additionally known as wireless adhoc network or adhoc wireless network that typically contains a routable networking atmosphere on top of a Link Layer ad hoc network.. They carries with itset of mobile nodes connected wirelessly during a self designed, self healing network while not having a fixed infrastructure. Manet nodes are unengaged to move every which way because the topology changes oftentimes. Every node behave as a router as they forward traffic to alternative given node within the network. MANET might operate as standalone fashion or they can be the part of larger internet. They form extremely dynamic autonomous topology with the presence of 1or multiple completely different transceivers between nodes.The main challenge for the MANET is to equipped every devices to incessantly maintain the information needed to properly route traffic. MANETs consist of a peer-to-peer, self-forming, self-healing network MANET's circa 2000-2015 usually communicate at radio frequencies (30MHz-5GHz).This can be used in road safety, starting from sensors for environment, home, health, disaster rescue operations, air/land/navy defense, weapons, robots, etc.

1.2 AODV
An Ad Hoc On-Demand Distance Vector (AODV) is a routing protocol made for wireless and mobile ad hoc networks. This protocol creates routes to destinations on demand and supports both unicast and multicast routing. The AODV protocol was jointly designed by Nokia Research Center, the University of California, Santa Barbara and the University of Cincinnati in 1991.The AODV protocol builds routes between nodes when requested by source nodes. That's why AODV is considered as an on-demand algorithm and does not create any extra traffic for communication along links. The routes are maintaned as long as they are needed by the sources. AODV makes use of sequence numbers to make sure route freshness. They're self-starting and loop-free besides scaling to various mobile nodes.
In AODV, networks are silent till connections are established. Network nodes broadcast a request for connection when need connections. The remaining AODV nodes forward the message and record the node that requested an affiliation. Thus, they produce a series of temporary routes back to the requesting node. A node that receives such messages and holds a route to a desired node sends a backward acknowledgment message through temporary routes to the requesting node. The node that initiated the request uses the route containing the least number of hops through alternative nodes. The entries that are not utilized in routing tables are recycled after some period of time. If a link fails, the routing error is passed back to the transmittal node and also the method is continued.

1.3 Working of AODV
When a node wishes to send a packet to some destination, it checks its routing table to determine if it has a current route to the destination. If yes, forwards the packet to next hop node If No, it initiates a route discovery process [8].

1.3.1 Route discovery
It begins with broadcasting of RREQ to its neighbors specified for certain destination. Once an intermediate node receives a RREQ, It check its routing table for route to dest If found send RREP to source If not found it rebroadcast RREQ to its neighbor nodes by setting up a reverse route path to source node in its route table. It ignores RREQ if it is processed already [6]. Finally on reaching RREQ to destination node, It uncast RREP to source node by using reverse route to source node. The above procedure can be described visually as follows:

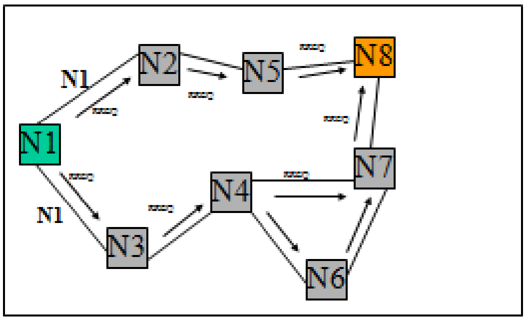

Fig 1: Route Discovery

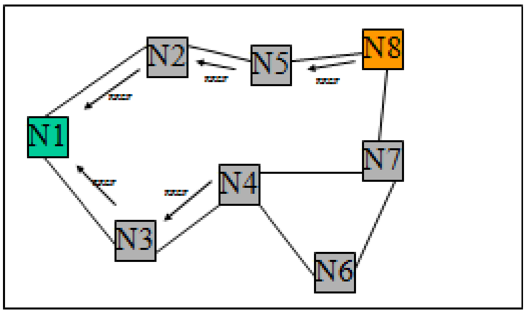

Fig 2: Route Reply

1.3.2 Route Maintenance Stage

A hello message is broadcasted by active nodes periodically. If no hello message from a neighbor The upstream node will notify the source with an RERR packet & entire routes based on the node is invalidated. Source will initialize a new route discovery stage and flood the RREQ packet [8]. Above procedure can be realized in the following figure:

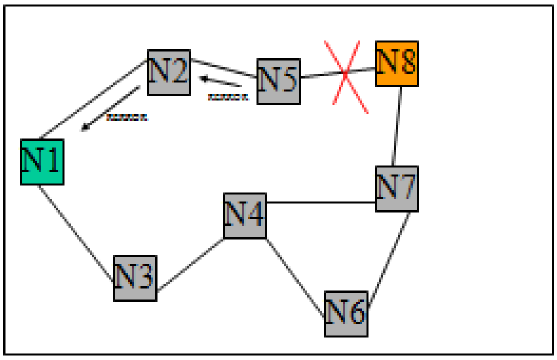

Fig 3: Propagation of RERR

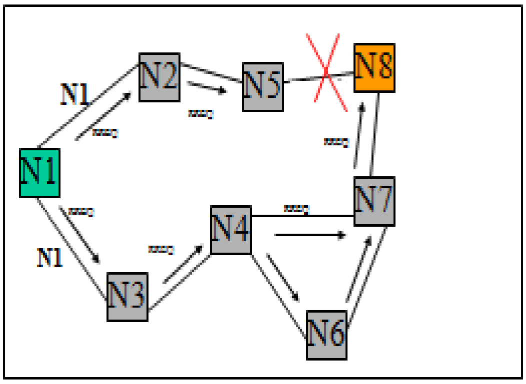

Fig 4: Route Rediscovery

2. EVALUATION CRITERIA

Performance of AODV protocols in MANET can be realized by quantitative study of values of different metrics used to measure performance of routing protocols which are as follows.

No of packet received : Total number of received packet.

No of packet sent: Total number of sending packet.

Packet delivery ratio(PDR): Packet delivery ratio is the ratio of total number of data packets received at destination to the total number of data packets sent from source.

PDR=Received packet/Packet sent*100

Control overhead: Control overhead means the number of routing packets which are required in the network for data transmission.

Control overhead=Routed Packet (rtr)

Normalized routing overhead (NRO): Normalized routing overhead is the ratio of number of routing packets to the total number of data packets received.

NRO=rtr/packet received*100

Delay: Delay is the time taken by packet to reach to destination from source.

Delay= delay/packet received

Throughput: Throughput means the average number of bits transmitted per unit time.

Throughput= bytes*8/ (End time of packet transmission-Starting time of packet transmission)/1000)

Packet Dropping Ratio (PDR): Packet dropping ratio is the ratio of total number of data packets dropped to the total number of data packets sent from source.

PDR=(packet sent-packet received)/packet sent*100).

3. SIMULATION MODEL

For the simulation of the developed system, latest version 2.34 of NS-2 has been used in this paper. NS2 is an open-source simulation tool that runs on Linux.It's a discreet event tool targeted at networking analysis and provides substantial support for simulation of routing, multicast protocols and IP protocols over wired and wireless (local and satellite) networks.It is mainly used in research works.The first version was NS-1 and it was developed at Lawrence Berkeley National Laboratory (LBNL) in the 1995-97.Then came NS-2 as a revision of NS-1.Then came NS-3 and NS-4.

4. SIMULATION PARAMETERS

There are number of simulation parameters which can be varied, results in change in value of different performance metrics, which can be shown in below table.

Table 1. Simulation Parameter

Sl No	Parameter	Value
1	Simulator	NS-2 (Version 2.34)
2	Channel type	Channel/Wireless channel

3	Radio Propagation Model	Propagation/Two ray ground wave
4	Network interface type	Phy/WirelessPhy
5	MAC Type	Mac /802.11
6	Interface queue Type	Queue/Drop Tail
7	Link Layer Type	LL
8	Antenna	Antenna/Omni Antenna
9	Area (M*M)	500*500
10	Simulation Time	30
11	No of Nodes	10-100
12	Routing Protocol	AODV

5. SIMULATION SCENARIO

There can be the possibility of following two scenarios shown in fig 5 & 6 below one is, static where nodes are constant & another is dynamic where nodes are moving continuously which is consider in this paper.

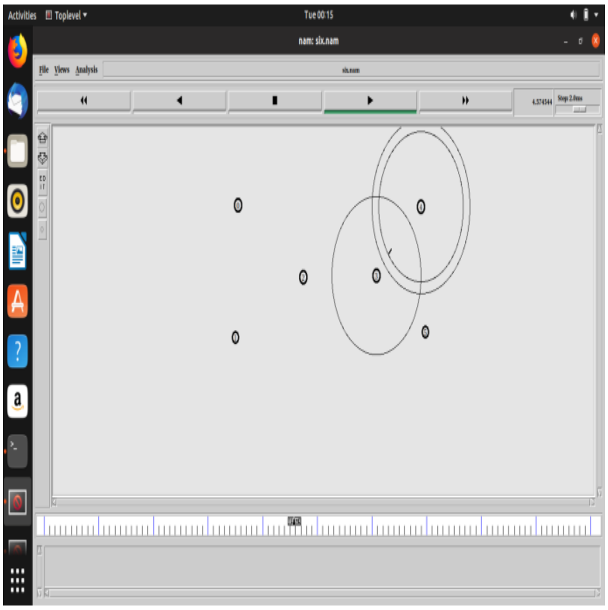

Fig 5: Static Simulation Scenario

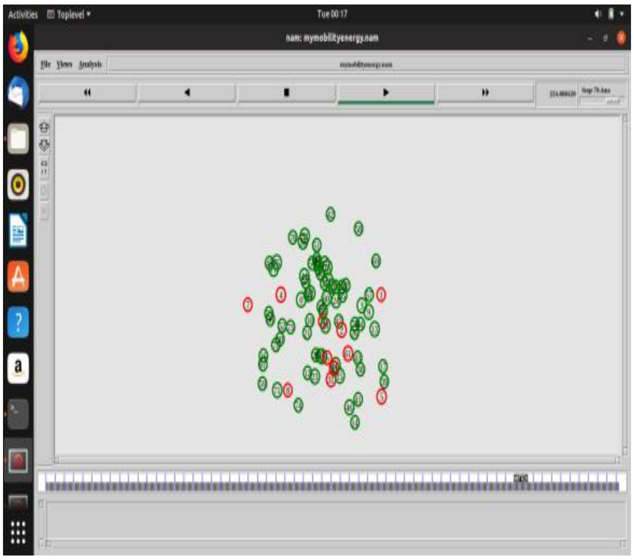

Fig 6: Dynamic Simulation Scenario

6. RESULT AND ANALYSIS

Using Random Waypoint Mobility Model analysing by increasing the number of nodes upto 100 to check the performances of the AODV protocol in terms of some metices given below varying speed.

6.1 For Throughput

Table 2. Simulation Result for Throughput

no. of nodes	speed1	speed3	speed5	speed7	speed10
10	65.15	64.92	79.85	79.06	69.92
20	51.39	80.99	66.77	79.22	67.2
30	64.81	76.07	80.42	78.91	64.42
40	74.59	75.29	79.66	76.47	68.8
50	78.82	65.89	84.12	68.52	73.72
60	45.97	77.2	78.87	67.03	77.99
70	71.48	71.9	78.44	78.78	59.99
80	67.81	75.93	67.31	74.54	79.66
90	77.48	78.78	36.81	78.72	71.81
100	77.8	40	74.46	80.87	77.77

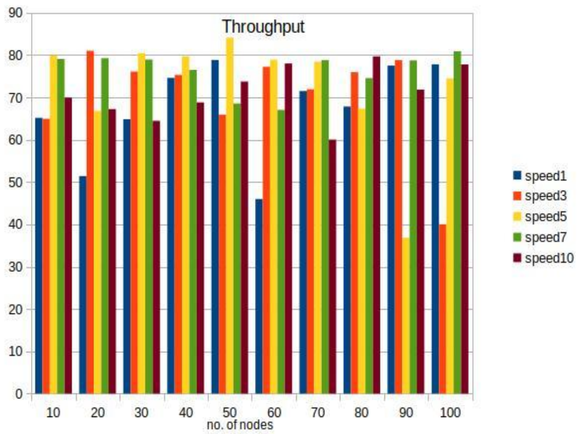

Fig 7: Simulation graph for Throughput

6.2 For No of Packet Received

Table 3. Simulation Result for No of packet received

no. of nodes	speed1	speed3	speed5	speed7	speed10
10	3552	4413	6469	6043	5787
20	3759	4842	5057	5732	5857
30	3363	4848	4653	6959	4559
40	3771	4100	6025	4385	4338
50	5472	4029	7852	4844	4103
60	4293	3926	6066	3893	5677
70	3521	4664	6034	4909	5602
80	4283	5047	4994	3377	6643
90	4884	5553	3436	5638	4728
100	5426	3735	4974	5400	6531

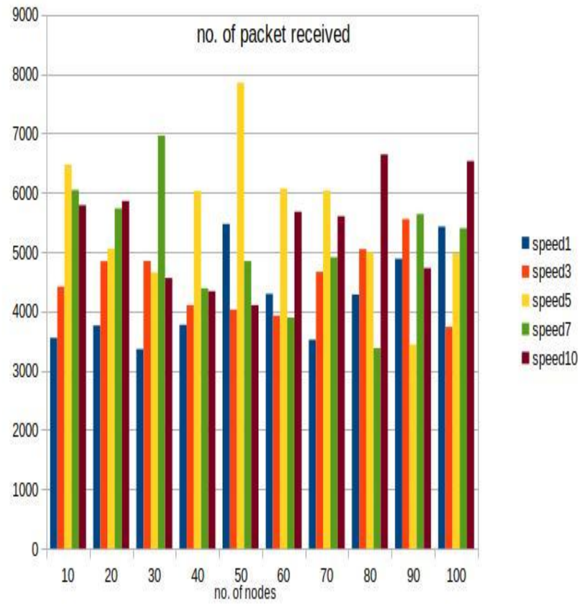

Fig 8: Simulation graph for No of packet received

6.3 For No of Packet Sent

Table 4. Simulation Result for No of packet sent

no. of nodes	speed1	speed3	speed5	speed7	speed10
10	3734	4788	6881	6447	6466
20	5019	4886	5832	6054	6775
30	3857	5159	4711	7520	5219
40	3889	4303	6347	4580	4609
50	5740	4500	8262	5350	4335
60	6048	3996	6539	4193	6033
70	3755	5124	6526	5060	7000
80	4647	5378	5463	3414	7125
90	5089	5838	5517	5967	4946
100	5705	5711	5379	5538	7047

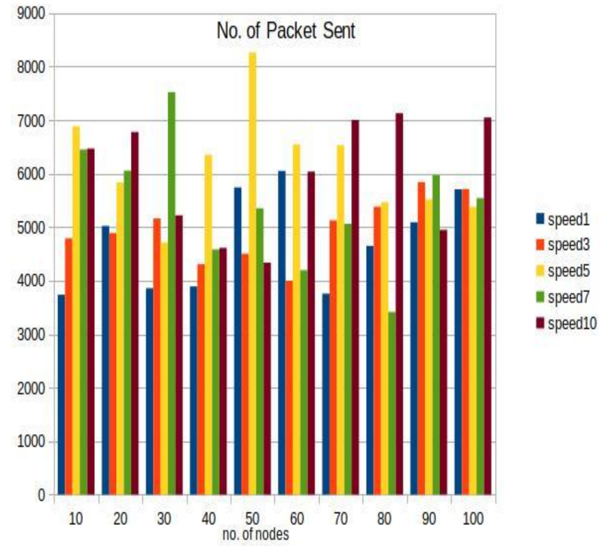

Fig 9: Simulation graph for No. of Packet sent

6.4 For Packet Delivery Ratio

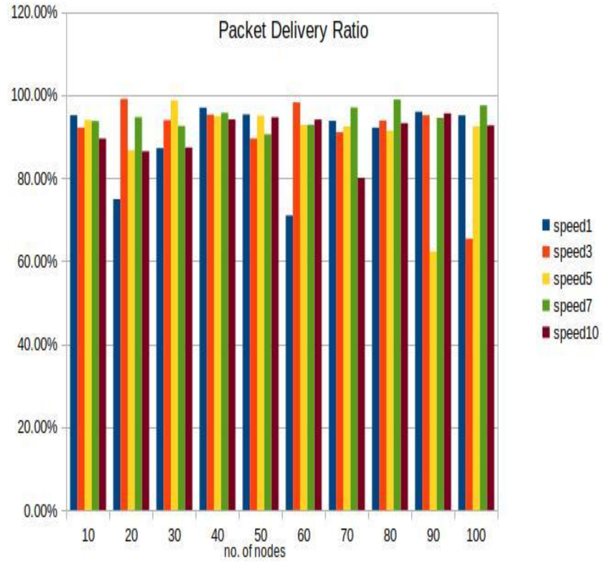

Fig 10: Simulation graph for Packet Delivery Ratio

Table 5. Simulation Result for No of packet delivery ratio

no. of nodes	speed1	speed3	speed5	speed7	speed10
10	95.13%	92.17%	94.01%	93.73%	89.50%
20	74.90%	99.10%	86.71%	94.68%	86.45%
30	87.19%	93.97%	98.70%	92.54%	87.35%
40	96.97%	95.28%	94.93%	95.74%	94.12%
50	95.33%	89.53%	95.04%	90.54%	94.65%
60	70.98%	98.25%	92.77%	92.85%	94.10%
70	93.77%	91.02%	92.46%	97.02%	80.03%
80	92.17%	93.85%	91.41%	98.92%	93.24%
90	95.97%	95.12%	62.28%	94.49%	95.59%
100	95.11%	65.40%	92.47%	97.51%	92.68%

6.5 For Control Overhead

Table 6. Simulation Result for Control overhead

no. of nodes	speed1	speed3	speed5	speed7	speed10
10	190	173	193	206	182
20	496	181	272	211	315
30	737	353	249	305	314
40	667	586	340	390	454
50	783	494	341	550	524
60	1833	481	848	522	447
70	945	979	912	485	1069
80	1821	701	654	703	581
90	1770	560	1594	563	600
100	1196	1434	928	641	894

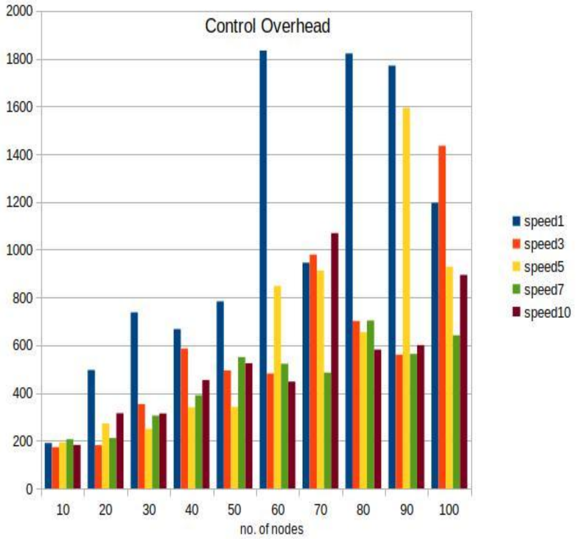

Fig 11: Simulation graph for Control Overhead

6.6 For Normalized routing overhead

Table 7. Simulation Result for Normalized routing overhead

no. of nodes	speed1	speed3	speed5	speed7	speed10
10	5.35%	3.92%	2.98%	3.41%	3.14%
20	13.19%	3.74%	5.38%	3.68%	5.38%
30	21.91%	7.28%	5.35%	4.38%	6.89%
40	17.69%	14.29%	5.64%	8.89%	10.47%
50	14.31%	12.26%	4.34%	11.35%	12.77%
60	42.70%	12.25%	13.98%	13.41%	7.87%
70	26.84%	20.99%	15.11%	9.88%	19.08%
80	42.52%	13.89%	13.10%	20.82%	8.75%
90	36.24%	10.08%	46.39%	9.99%	12.69%
100	22.04%	38.39%	18.66%	11.87%	13.69%

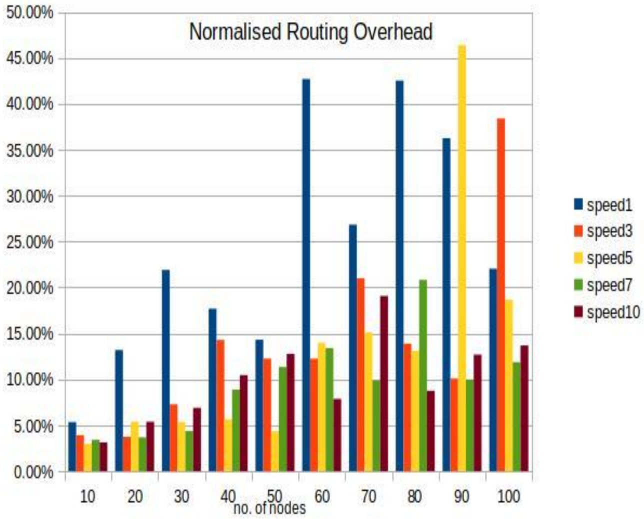

Fig 12: Simulation graph for Normalised Routing Overhead

6.7 For Delay

Table 8. Simulation Result for Delay

no. of nodes	speed1	speed3	speed5	speed7	speed10
10	0.02	0.01	0.01	0.01	0.01
20	0.02	0.01	0.01	0.01	0.01
30	0.04	0.01	0.01	0.01	0.01
40	0.02	0.02	0.01	0.01	0.08
50	0.01	0.02	0.01	0.02	0.02
60	0.01	0.02	0.09	0.01	0.01
70	0.09	0.07	0.05	0.01	0.06
80	0.22	0.01	0.01	0.03	0.01
90	0.18	0.01	0.1	0.01	0.01
100	0.01	0.02	0.02	0.01	0.01

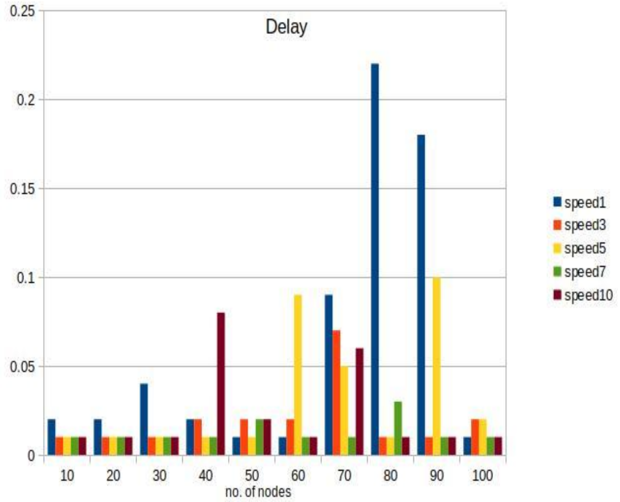

Fig 13: Simulation graph for Delay

6.8 For Packet Dropping Ratio

Table 9. Simulation Result For Packet Dropping Ratio

no. of nodes	speed1	speed3	speed5	speed7	speed10
10	4.87%	7.83%	5.99%	6.27%	10.50%
20	25.10%	0.90%	13.29%	5.32%	13.55%
30	12.81%	6.03%	1.23%	7.46%	12.65%
40	3.03%	4.72%	5.07%	4.26%	5.88%
50	4.67%	10.47%	4.96%	9.46%	5.35%
60	29.02%	1.75%	7.23%	7.15%	5.90%
70	6.23%	8.98%	7.54%	2.98%	19.97%
80	7.83%	6.15%	8.59%	1.08%	6.76%
90	4.03%	0.88%	37.72%	5.51%	4.41%
100	4.89%	34.60%	7.53%	2.49%	7.32%

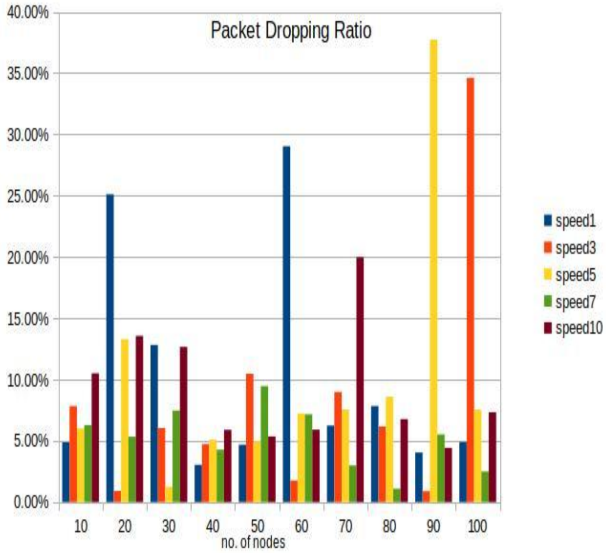

Fig 14: Simulation graph for Packet Dropping Ratio

7. ANALYSIS

In observation of simulation with NS-2, we found non linear change in the values of the matrices like Throughput, Number of packets sent, Number of packets received, Packets delivery ratio, Control overhead, Packet dropping ratio, Delay, Normalized routing overhead.

8. CONCLUSION

Thus we have evaluated the performance of very popular on demand routing protocol AODV, by means of various performance metrics such as Throughput, Number of packets sent, Number of packets received, Packet delivery ratio, Control overhead, Packet dropping ratio, Delay, Normalised routing overhead as well obtained simulation results by varying number of nodes in the network & speed & found that there is non linear change in the values of these metrics.

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