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PERFORMANCE ANALYSIS OF RANDOMIZED REVERSE AD HOC ON DEMAND DISTANCE VECTOR ROUTING PROTOCOL IN MANET

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ABSTRACT

In high mobility, routing in Mobile Ad-Hoc Network is a very difficult task. In AODV and RAODV, all the data packets are travel through the same shortest path so the intruders can easily trace out the data path. The main objective of Randomized RAODV provides the multipath and then the paths are selected randomly for security purposes. Using randomized routing algorithm to choose the path randomly and then the data packets are travel through different path to reach the destination, so the hackers cannot know about what are the ways the data packets traverse. The performance of proposed RRAODV is compared with the existing routing protocol like AODV, RAODV in mobile network environment. Performance metrics such as packet delivery ratio, end to end delay and control packet overhead are evaluated using NS-2 based on the number of nodes and speeds. Simulation results shows RRAODV gives better performance than the existing protocols like AODV and RAODV for the above metrics. RRAODV is helpful to increase the performance of data transmission and security of data.

Keywords: Multipath, Ad Hoc On Demand Distance Vector (AODV), Security, Reverse Ad Hoc On Demand Distance Vector (RAODV), Security, Randomized Reverse Ad Hoc On Demand Distance Vector (RRAODV)

1. INTRODUCTION

A mobile Ad-hoc Network is a collection of interrelated nodes with no infrastructure and a multi hop wireless network with no centralized administration. The nodes in a mobile Ad-hoc network change dynamically such as some nodes join in a network, disconnect the network and also move at any time on the network. In the above reasons, the routing problem in MANET is more difficult than compared to the wired network.

Routing protocols in Ad-hoc network is grouped under three categories like proactive, reactive and hybrid routing protocols. In proactive type of routing protocols, the routing information in each node of a network is updated periodically whether the routing path is needed or not. DSDV and OLSR are example of proactive routing protocol.

Examples of Reactive routing protocols are AODV, DSR and TORA. This type of routing protocol maintain route only for data communication. These type of protocol helps to reduce routing overhead. Zone based Routing Protocol (ZRP) is an example of hybrid routing protocol. It combines the features of proactive and reactive routing protocols.

The rest of the paper is organized as follows. In the next section describes related work, third section describes proposed work, fourth section explains the

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simulation results and parameters. Finally, conclusion is added in the last section.

2. RELATED WORK

Split multipath routing (Lee and Gerla, 2001) is used to construct maximally disjoint paths in ad hoc networks. The destination node receives multiple RREQ packets and then selects the two maximum disjoint paths. AOMDV (Marina and Das, 2001) computes multiple loop-free and link-disjoint paths in AODV for route discovery but it cannot maintain the alternate path properly.

NMN-AODV protocol (Zangeneh and Mohammadi, 2011) based on AODV protocol and it improves the packet delivery ratio, reduces end-to-end delay and also uses two node disjoint routes between source and destination pair. MMDV (Mtibaa and Kamoun, 2006) protocol provides multipath and MPR based flooding in AODV and this protocol establishes multiple and disjoint path in a single route discovery process but cannot easy to handle congestion and collisions in high node density.

NDMR (Li and Cuthbert, 2004) protocol to reduce routing overhead and also achieves multiple node-disjoint routing paths in AODV but it decrease the performance when increase the routing load. MP-AOMDV (Sambasivam *et al*., 2004) protocol form the multiple path and it validate all the alternate path periodically using periodic update packets.

Kuo *et al*. (2009) author describes dynamic routing in DSDV for security purposes. The path between multiple sources to their multiple destinations is stored on a routing table and the paths are selected randomly by the source node and then the data packets are sent through this path.

RAODV (Kim *et al*., 2006) is the extension of AODV protocol. This protocol is helpful to decrease the loss of RREP packet and also prevent a retransmission of RREQ by the source node when the link is disconnected, so the congestion is reduced in a network.

Jaisankar and Saravanan (2010), authors compute multiple routes in a single route discovery and it produce node disjoint path and fail safe path for multiple routes. Path Hopping Based on Reverse AODV for security (Talipov *et al*., 2006) is the extension of RAODV. In this protocol, the source node stores multiple paths to the destination node and then the paths are selected sequentially from the list. SecMR (Kotzanikolaou *et al*., 2005) protocol together with AODV for security purposes and it discovers the complete set of non-cyclic and node-disjoint path. Taleb and Behzad (2012), the author performs the simulation study to compare the number of hops in selected path along route reply of AODV and RAODV. They conclude that RAODV data packets meet fewer hops in chosen path and remind energy is higher than AODV.

Khelifa and Maaza (2010), author computes the residual energy of nodes in RAODV, EA-RAODV (Gouda and Behera, 2012) is the extension of RAODV which is based on the combination of least hops, power and minimum remaining energy. RAODV (Das, 2013) has better performance than AODV for larger network size and low density networks with lower network mobility. Zarei *et al*. (2008) develop an algorithm and it is based on link/route stability estimation for decrease overhead of discovery and maintenance of routing. Humaira *et al*. (2011), Authors compare the performance of AODV and RAODV using the parameters like Throughput, Delay and packet delivery ratio and conclude that RAODV has better performance than AODV. An enhanced DOA (Vanitha and Parvathavarthini, 2013) to reduce the problem of position estimation error along with DTS and to estimate the nearest neighbor selection.

3. PROPOSED WORK

This protocol is the extension of Reverse-AODV protocol and it is based on distributed routing information. This one is helpful to improve the security of data transmission. This protocol has multipath routing path to the destination node. Multipath is more advantage in large networks and also provides load balancing. It is helpful to establish more than one path between source and destination node. If the link is failed in a network then the data packets are correctly and securely reach to the destination node using alternate paths to the destination node.

3.1. Route Discovery

Source node broadcast the RREQ packet to their neighborhood nodes within their transmission range. The content of the RREQ packet is as follows.

Broadcast ID is uniquely identifying the Route Request (RREQ) packet. The neighborhood node receives RREQ packet which is a destination node it prepares Reverse Route Request (R-RREQ) packet otherwise it forwards to the next neighborhood nodes and this process continues finally this packet reach to the destination nod. When an intermediate node receives multiple copies of the same RREQ packet then it accepts the first RREQ packet and drops the remaining RREQ packet (**Fig. 1**).

The destination node only generates the R-RREQ packet and it makes this packet only when it receives the first RREQ packet from the source node. The format of the R-RREQ packet is as follows (**Fig. 2**).

Destination node broadcast the R-RREQ packet within the transmission range. When an intermediate node receives R-RREQ packet, if it already have the same R-RREQ packet then it drops it otherwise it forward to the next neighborhood nodes on the network. Each node maintains the routing table. The content of the routing table is as follows.

Source node collects the R-RREQ packet from the various neighborhood nodes. Based on the information of routing **Table 1**, source node selects the path randomly from the routing table for security purposes. Applying randomized algorithm to choose the path randomly on the routing table. Source node selects the path randomly on the routing table and it is used to forward the data packets.

3.2. Route Maintenance

Hello packet is used to detect whether the link is failed or not. When the link is failed in a network, neighborhood node of the failed link sends RERR packet to the source node.

Type	Reserved	Hop Count
Broadcast ID		
Destination IP address		
Destination sequence number		
Originator IP address		
Originator sequence number		
Time stamp		

Fig. 1. RREQ message format

Type	Reserved	Hop Count
Broadcast ID		
Destination IP address		
Destination sequence number		
Originator IP address		
Time stamp		

Fig. 2. R-RREQ message format

Table 1. Routing table

Destination	Source IP address	Destination sequence number	Hop count	Next hop list

When the source node receives the RERR packet, it immediately removes the failed path in their routing table and it chooses another path on the routing table. If a single path between the source and destination is available then all the data packets are travel through the same path. Source node generates RREQ packet only for no path is available on the routing table. So it helpful to avoid extra overhead generated by a fresh route discovery and to reduce the route error transmission during route break recovery.

In randomized RAODV, source node selects the available path randomly in a routing table for data transfer to the destination node i.e., source node selects the different path in each time. In this study, compare the performance of AODV, RAODV and Randomized RAODV using the parameters like Packet Delivery Ratio, End to End Delay, Throughput, Packet Loss and Control Packet Overhead. The above metrics are helpful to analyze the performance of the Randomized RAODV. Packet delivery ratio value and Throughput value is high means the performance of the network is high; If the value of End to End delay, Control packet overhead and packet loss is low means degrade the better performance of the protocol.

4. MATERIALS AND METHODS

Simulations are helpful to evaluate the performance of the Randomized RAODV and also compare the performance of AODV, RAODV and Randomized RAODV. The simulation environment for performance analysis is shown in **Table 2**.

Detailed performance analysis of AODV, RAODV and Randomized RAODV using the parameters like Packet delivery ratio, Average end-to-end delay, Throughput, Packet loss, Control packet overhead. Two different scenarios are used to evaluate the above parameters. One scenario is varying the number of nodes but speed is constant and other is varying speed but node is constant.

Table 2. Simulation Parameters

Parameter	Value
Simulator	ns-2.34
Protocols	AODV, RAODV, RRAODV
Number of nodes	40,60,80,100,120,140
Simulation Area	1000×1000 m
MAC Layer	IEEE 802.11
Radio Transmission range	250 m
Movement Model	Random Way Point Model (RWP)
Traffic type	CBR
Mobility	10 ms
Propagation	Two ray ground
Agent	UDP agent
Data Payload	512 bytes/packet

5. RESULTS

5.1. Scenario 1-Network with Varying Number of Nodes

In scenario 1, AODV, RAODV and RRAODV are analyzed using the parameters like packet delivery ratio, end to end delay and Control packet overhead using varying the number of nodes (40, 60, 80, 100, 120 and 140) and the speed of the nodes is constant (20 m s^{-1}).

5.1.1. Packet Delivery Ratio (PDR)

Packet Delivery Ratio = ∑ Number of packet receive/∑ Number of packet send

Figure 3 shows the packet delivery ratio and it is calculated as the ratio of packets delivered to the destination node to the total number of packets generated at the source node. When the number of nodes is minimum 40 nodes, PDR of Randomized RAODV has 96% and others have 52 and 68%. When the number of nodes increased to 100 and 140, Packet delivery ratio of Randomized RAODV is decreased to 66 and 68%. When the number of nodes increases, the mobility of nodes is also high. Randomized RAODV has better performance of the metric PDR for the number of nodes varies.

5.1.2. End to End Delay

End to End Delay = ∑ (arrive time-send time)/∑ Number of connections

End to end delay means the ratio of inter arrival time between the two packets to the total packets delivery time. In **Fig. 4**, End to End delay is very low in Randomized AODV compared to AODV and RAODV. End to End delay of Randomized RAODV has around 97.33% than AODV and 95.5% than RAODV.

5.1.3. Control Packet Overhead

In **Fig. 5**, Control packet overhead is less in Randomized RAODV compare to AODV and RAODV.

It measures the total number of control packets. Randomized RAODV has around 62% over in AODV and 35% over in RAODV.

5.2. Scenario 2-Network with Varying Speed of Nodes

In scenario 2, AODV, RAODV and RRAODV are analyzed using the parameters like packet delivery ratio, end to end delay and control packet overhead using varying the speed of nodes (10, 20, 30, 40 and 50 m s^{-1}) with the number of nodes is constant (60).

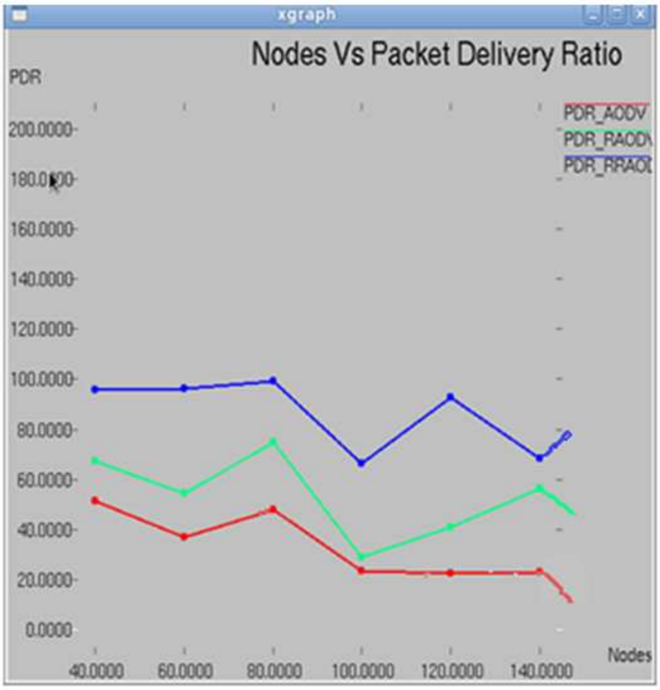

Fig. 3. Packet delivery ratio Vs number of nodes

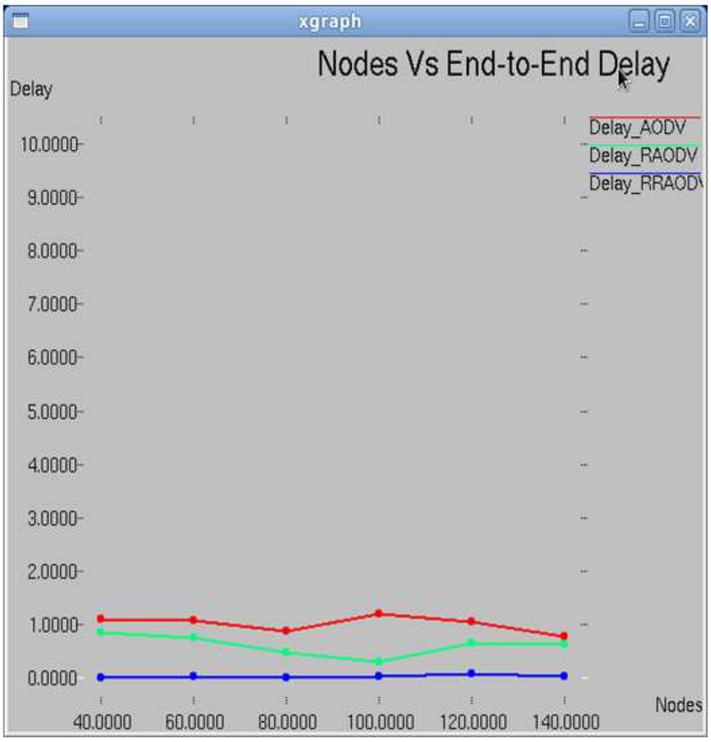

Fig. 4. End to end delay Vs number of nodes

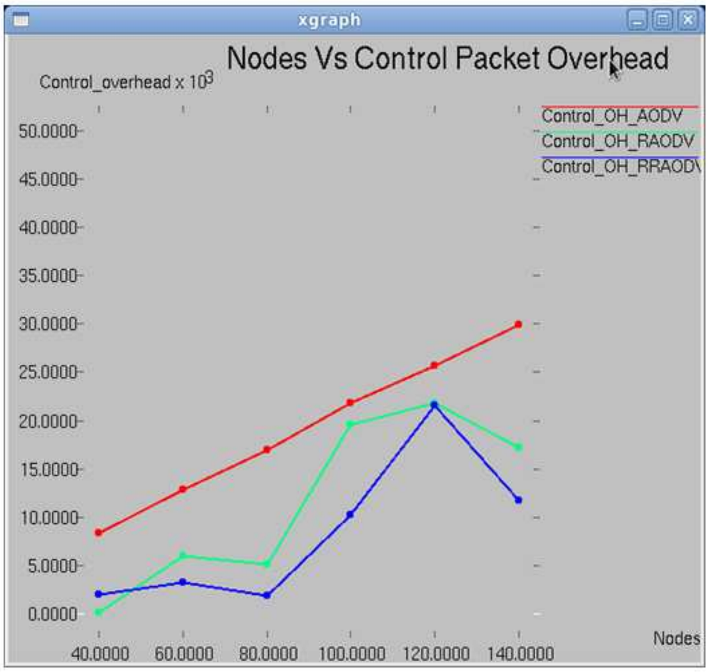

Fig. 5. Control packet overhead Vs number of nodes

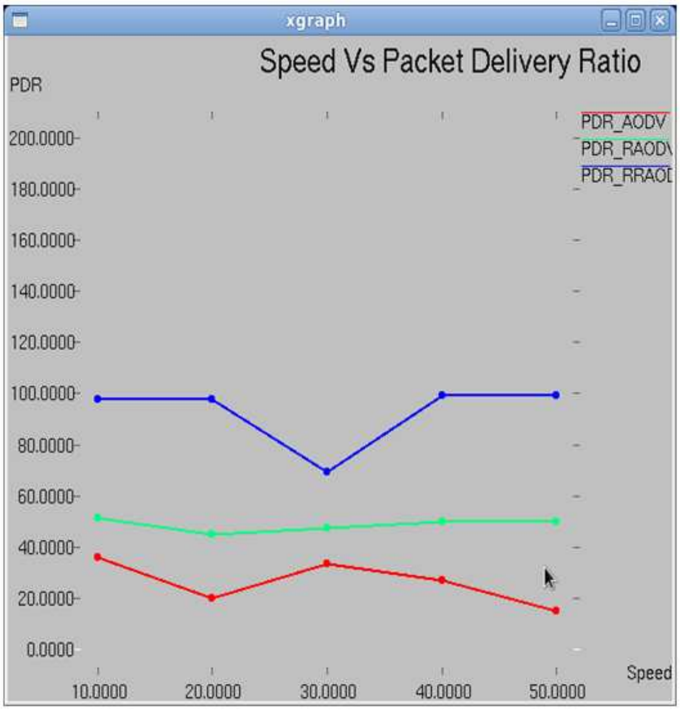

Fig. 6. Packet delivery ratio Vs speed

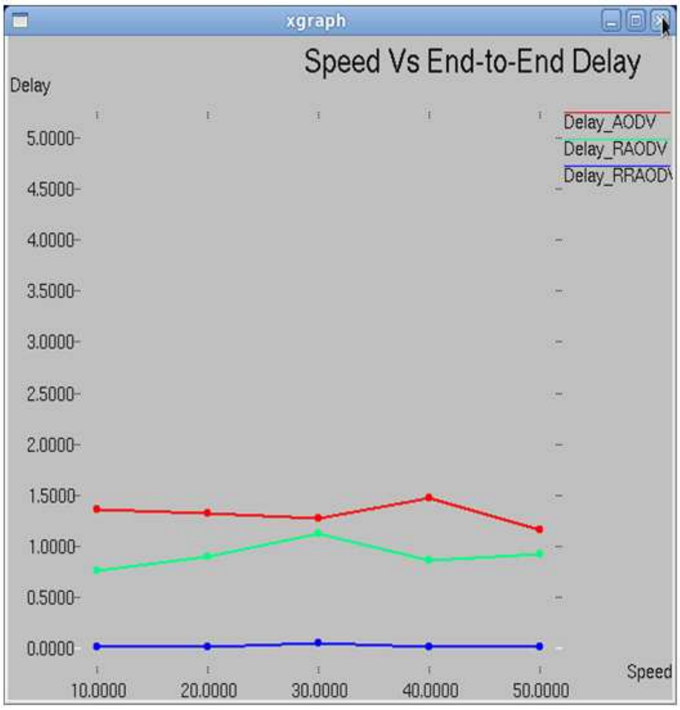

Fig. 7. End to end delay Vs speed

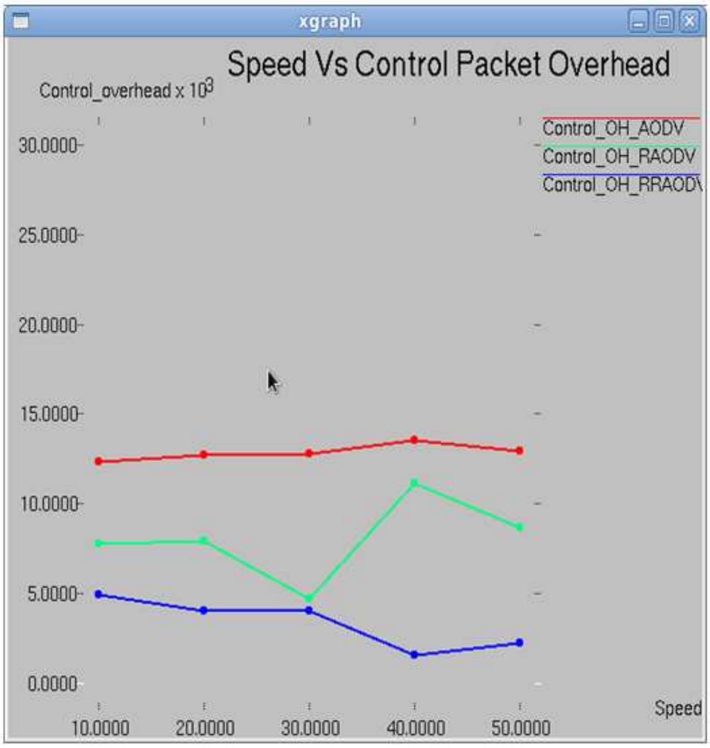

Fig. 8. Control packet overhead Vs speed

5.2.1. Packet Delivery Ratio (PDR)

Figure 6 shows the packet delivery ratio Vs Speed of AODV, RAODV and RRAODV. When the speed of the node is increased, packet delivery ratio is high in RRAODV compare to AODV and RAODV. RRAODV has 300% over AODV and 90.6% over RAODV.

5.2.2. End to End Delay

In **Fig. 7**, End to End delay is very low in Randomized AODV compared to AODV and RAODV.

End to End delay of AODV is nearly 1.31 ms, RAODV has 0.91 ms but RRAODV has 0.03ms. End to End delay of Randomized RAODV has around 97.4% than AODV and 97% than RAODV.

5.2.3. Control Packet Overhead

In **Fig. 8**, Control packet overhead is much reduced in Randomized RAODV compare to AODV and RAODV. Randomized RAODV has around 74% over in AODV and 52% over in RAODV.

6. DISCUSSION

Performance of the AODV, RAODV and Randomized RAODV is analyzed based on the number of nodes is represented in **Table 3**. Based on the result, Randomized RAODV has better performance on the nodes 40, 60 and 80 in the parameters packet delivery ratio, end to end delay and control packet overhead. When number of node is increased, the performance of the Randomized RAODV has changed.

In **Table 3**, using the parameter packet delivery ratio Randomized RAODV has 172.83% over AODV and 71.17% over RAODV. In End to end delay RRAODV has nearly 96% over AODV and RAODV. In control packet overhead, RRAODV has around 62% over AODV and 35% over RAODV.

Table 4 shows the analysis results of the performance of AODV, RAODV and Randomized RAODV based on the speed. Randomized RAODV has achieved high packet delivery ratio i.e., 300% over AODV and 90% over RAODV using various speed of the network and delay is 97% over AODV and RAODV and also control packet overhead is 74% over AODV and 52% over RAODV.

Table 3. Performance analysis of AODV, RAODV and randomized RAODV With respect to number of nodes

Speed = 20 m/s (Constant)

Packet delivery ratio (%) Vs No. of nodes

Number of nodes	AODV	RAODV	Randomized RAODV	Average efficiency of randomized RAODV
40	52.000	68.000	96.000	172.83% over AODV
60	37.000	54.000	96.000	71.17% over RAODV
80	48.000	75.000	99.000	
100	23.000	29.000	66.000	
120	23.000	41.000	93.000	
140	23.000	56.000	68.000	
End to end delay (ms) Vs no. of nodes				
40	1.096	0.847	0.006	97.33% over AODV
60	1.083	0.742	0.013	95.5% over RAODV
80	0.876	0.483	0.006	
100	1.190	0.289	0.014	
120	1.042	0.644	0.085	
140	0.761	0.625	0.033	
Control packet overhead (Bytes) Vs no. of nodes				
40	8309.000	114.000	1998.000	61.83% over AODV
60	12891.000	6035.000	3293.000	34.5% over RAODV
80	16976.000	5145.000	1842.000	
100	21879.000	19625.000	10183.000	
120	25712.000	21815.000	21565.000	
140	29898.000	17261.000	11771.000	

Table 4. Performance analysis of AODV, RAODV and randomized RAODV With respect to speeds

Number of node = 60 (Constant)

Packet delivery ratio (%) Vs speed (m/s)

Speed	AODV	RAODV	Randomized RAODV	Average efficiency of randomized RAODV
10	36.0000	51.000000	98.0000000	300% over AODV
20	20.00000	45.000000	98.0000000	90.6% over RAODV
30	33.00000	47.000000	69.0000000	
40	27.00000	50.000000	99.0000000	
50	15.00000	50.000000	99.0000000	
End to end delay (ms) Vs speed (m/s)				
10	1.35991	0.762293	0.0090940	97.4% over AODV
20	1.32318	0.892619	0.0102669	97% over RAODV
30	1.26603	1.126830	0.0528512	
40	1.46916	0.855379	0.0087620	
50	1.15514	0.916582	0.0664095	
Control packet overhead (Bytes) Vs speed (m/s)				
10	12360.00000	7743.000000	4955.0000000	97% over RAODV
20	12747.00000	7917.000000	4012.0000000	52% over RAODV
30	12775.00000	4714.000000	4001.0000000	
40	13538.00000	11180.000000	1532.0000000	
50	12925.00000	8648.000000	2229.0000000	

7. CONCLUSION

In Randomized RAODV, the source node collects multiple paths from the destination node and all the path information is stored on the routing table based on hop count. The source node chose the path randomly in the routing table for the security purposes. Intruders cannot identify which way the data packets are travel to reach the destination node. The simulation work is based on the metrics for packet delivery ratio, throughput, control packet overhead, packet loss and end to end delay. Using these parameters, Randomized RAODV has better performance than AODV and RAODV with respect to the number of nodes and speeds. But bandwidth consumption is high in Randomized RAODV due to multiple path selection. Our future work will focus on introducing various attacks and then monitoring the performance of Randomized RAODV.

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