A Modified Approach to Improve Security and Congestion Control in AODV Routing Protocol against Blackhole Attack

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***Abstract*—**A Wireless ad-hoc network is an impermanent network set up by wireless mobile nodes moving random in those spots which have no network framework (infrastructure) or incorporated (centralized) access point. Since the independent nodes have ability to interconnect with each other, they collaborate with one another by sending information packets to different nodes in the system. Thusly the nodes determines a route to the terminus node by means of routing protocols. Wireless ad-hoc networks are vulnerable to assaults of mischievous nodes because of security liabilities of the routing protocols. One of this kind of attack is Blackhole Attack and this kind of assault influences network integrity by stimulating all information packets in the network. In this research paper we intend a solution, which improves the security of Ad-hoc on-demand distance Vector (AODV) routing protocol to prohibit Blackhole attack. So we analyze the influence of a Blackhole assault in a mobile ad hoc network and associate it with our recommended AODV routing protocol. For examining execution and concert of our recommended algorithm, performance metrics are taken into consideration such as system throughput, no. of packets send, received and dropped, packet delivery ratio and average end-to-end delay.

Keywords*-*MANET, AODV, Blackhole attack, RTS, CTS.

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I. INTRODUCTION

A Mobile Ad Hoc network is a self-organizing system which is designed instinctively by an assortment of mobile nodes with no settled framework. They interconnect with one other specifically on the off chance that they are in a similar wireless communication area. Uncertainty, when these are obtainable out from the wireless range then the communication would involve the collaboration of different nodes. Accordingly, every movable node has to function not only as a host but also as a router. Because these individualities are utilized as a part of many critical applications such as emergency operations, vehicular computing, mobile offices and some more.

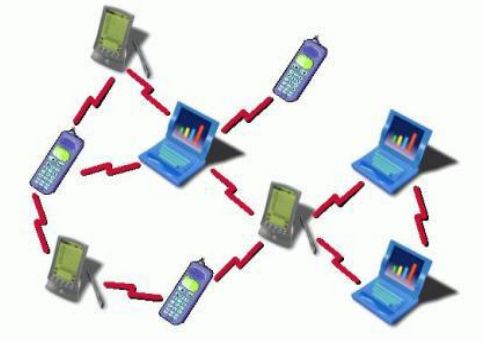

Fig 1. Mobile Ad-hoc Networks

In MANETs, a standout amongst the most difficult assignments is the security. As per its centralindividualities, for example, open medium, dynamic topology, disseminated collaboration, and constrained ability, MANETs end up simply incapable to the security attacks. Henceforth, different attacks [11-13] of various layers may influence the network.

A standout amongst the most acclaimed assaults in MANETs is the Blackhole assault [14], which is most effective on reactive routing protocols such as AODV [15]. In this assault, a mischievous node can pull all information packets by falsely emphasizing a crisp path or most brief path to terminus, deprived of having any active path to the predetermined goal, and afterward retains them without progressing it to the destination node.

Physical Carrier Sense is utilized when a transportable purchaser device trying to convey first surveys the channel. On the off chance that the energy identified on the network is over a specific limit (the carrier sense threshold), the channel is considered occupied, and the node must hold up. Something else, the channel is accepted sit without moving, and the node is allowed to communicate. A Virtual Carrier Sense utilizes an exceptional handshake to "hold" the channel, called the RequestToSend (RTS)/ClearToSend (CTS) mechanism.

In this research, our attention is on blackhole assaults. A Blackhole assault is an assault where every one of the packets in the system are diverted to a particular node (as blackhole node. The blackhole node mimics the goal node by forwarding a spoofed RREP packet to the source node which has started course revelation. A blackhole node has two belongings. Initially, the node feats the adhoc routing protocol, for example, AODV or DSR, to promote itself as having a legitimate course to the destination node, despite the fact that the course is spurious, with the expectation to capture packets.

Second, the node expends the fixed packets. This sort of assault is unsafe and may make tremendous harms the system.
This paper emphases on sensing blackhole nodes (i.e. mischievous nodes) in the system. This paper is divided into various sections that are explained as under i.e. In Section 2, the literature survey for Blackhole assault in reactive routing protocols are talked about. The fundamental ideas and preliminaries including Career sensing Range, AODV routing protocol and Blackhole assault are given in Sections 3 and 4 and 5 individually. The proposed strategy is given in Section 6. In Section 7, we talk over the method of calculating our result and the metrics used to contrast our proposed arrangement with the AODV routing protocol. Section 8 examines the experimental informationand conclusions are given in Section 9.

II. REVIEW OF LITERATURE

Jing Deng, et al. [1] and Kim et al. [2] examined that the carrier sensing range can fundamentally influence the MAC execution in multihop specially appointed systems.
Mustapha, et al. [3] researched the effect of detecting extent on the throughput by thinking about two fundamental issues in MAC they are simultaneous transmission, which is alluded to spatial reuse, and impact regarding transmission extend relentless likelihood and back-off time.
Vaidya [4] explored the effect of picking an ideal transporter sense extend by utilizing an expository model and also recreation comes about. Their outcomes uncover that the normal of throughput will be influenced unless the ideal transporter sense range is resolved legitimately.
In [5], Jain et al presented a calculation to identify and dispose of blackhole assaults. Author's method comprised of forwarding equivalent and little measured chunks of information and detecting the stream of information chunks autonomously at the area of source node and destination nodes.
In [6], Anita et al. suggested a system to recognize blackhole assaults utilizing a testament founded confirmation strategy that can secure blackhole assault.
In [7], Lu et al. proposed a blackhole discovery pattern (SAODV) which has talked about various security issues of AODV and continue on through the blackhole strike. An improved type of this SAODV convention is given by Deswal and Singh [8], where a maxim security is utilized for routing node and directing tables were revived in an opportuneness mold.
In [9], Raj et al. proposed an arrangement known as DPRAODV to perceive as well as detach blackhole strikes. Here a node perceived as blackhole node is prohibited and an ALARM packet is forwarded so that RREP packet which has begun from that harmful node is discarded and the routing table for that node is not invigorated. In any case, this estimation encounters extravagant overhead due to invigorate of thebreaking point a motivator at each time between time and the treatment of remarkable ALARM control packets.
In [10], Tamilselvan et al. proposed an answer for forestalling blackhole assaults in MANETs in view of AODV conventions. According to them, the source element holds up till various answers with the following jump points of interest. At the point when the source element gets the RREP packetsit records the gathering number close by the time the parcel arrived in an accumulate course answer table (CRRT). Subsequent to recording the course replies in the CRRT, it figures the timeout regard for each RREP in light of the time first RREP arrived, at that point it checks the CRRT for any repeated next jump nodes. The path with the repeated next bounce node is believed to be ensured. On the off chance that there is no rehashed next expectation node in the CRRT, the calculation picks an irregular way from the CRRT. The principle disadvantage of this course of action is that if there are no rehashed next bounce nodes in the CRRT, along these lines the estimation manufactures the threat of blackhole ambush by picking a self-assertive way.

Problem Formulation

Mobile ad-hoc network is that kind of network which contracts by means of communication between nodes without any intrusion of external device. In MANET various node have been used for communication from source to destination. Firstly, the source node broadcast a request message for data transmission over the network. Then, the intermediate nodes receives a request message and finds a route for the transmission of data and reply to source with all information about route.
In MANET numerous issues has been come across which degrades the performance of the network. Some of the problem is congestion which occurs in the network due to peer to peer communication. Sometimes a single node receives large amount of data more than a node needs to transmit data further to destination. Due to congestion, this problem gets prolonged to loss of data which occurred on a node. In Mobile ad-hoc networks route discovery mechanism has been taken into consideration for the generation of path from source to destination by virtue of which an optimal and feasible path can be selected. Optimum path assures definite (guaranteed) delivery of data from source to destination. Several algorithms had been purposed for congestion avoidance in MANET but these algorithms are too complex because that consumes too much time and that leads to increase in network overload. MANET is susceptible through numerous security assaults like modification, IP spoofing, DOS etc. Consequently, various researches has been done in this region.
Blackhole attack has a severe influence on reactive routing protocols. Many of researches has designed various approaches like IDS to recognize blackhole assault.

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So that in purposed work we have mitigate the Blackhole attack and Congestion Control in AODV by using concept of virtual carrier sensing and dummy packets.

III. CARRIER SENSING RANGE

Carrier sensing is a central framework in Carrier sense various passage by crash avoidance (CSMA/CA) traditions. This holds virtual carrier sensing that is known as RTS/CTS segment. To plot RTS/CTS, the source at first forwards a RTS message and destination response with a CTS. After that the genuine DATA/ACK interchange will be completed. Adjacent nodes which gets RTS or CTS, that nodes sets their Network Allocation Vector (NAV) with a specific goal to secure the channel for the coming DATA/ACK channel [2].

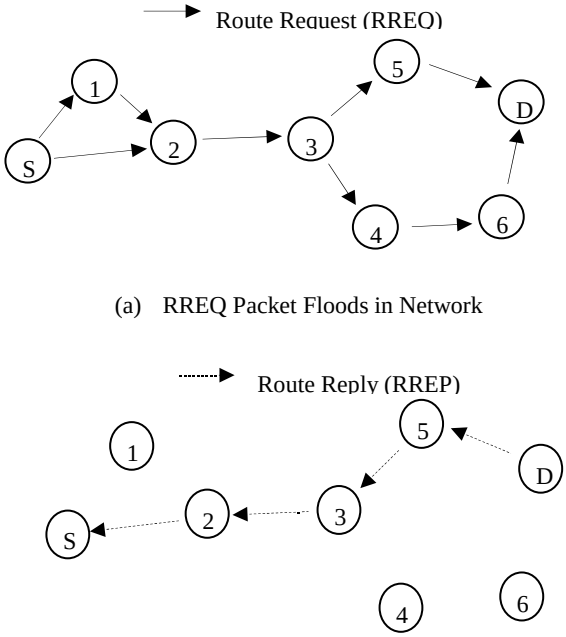
At the point when a node wants to transfer, the node firstly ought to sense the channel before transmission. In the event that it detects a bustling channel, it has to prematurely end the communication to maintain a strategic distance from or diminish crash. A bustling channel is recognized when the detected energy of the flag surpasses a particular limit alluded to as the Carrier Sense Threshold (CST). On the off chance that the flag power is inferior to this edge, the channel is considered to be a sit still channel [2].

The CST esteem chooses the detecting area and affects the crash probability and in addition simultaneous transmission in the MANET.

IV. AD HOC ON DEMAND DISTANCE VECTOR (AODV) [16]

The Ad Hoc On-Demand Distance Vector (AODV) directing convention depends on the Destination-Sequenced Distance-Vector (DSDV) and Distance Sequence Routing (DSR) calculation. AODV is on demand routing protocol and it has no reserved path. AODV attains two preeminent functionalities: A) Route Discovery and B) Route Maintenance.

A. In *Route Discovery* stage, the fundamental approach utilized by AODV is to build up a path by communicating Route REQuest (RREQ) packets in the system. At the point when a transitional node gets the demand packet, initially it checks whether a node which gets the demand packet is a destination node for that packet or not. Assuming this is the case, at that point the node sends a RREP (Route REPly) packet back to that element from which it has gotten the packet. In the event that that element is not the goal(destination) node, at that point it checks its entrance in its routing table to decide whether it has a crisp adequate routing to the goal node or not. If not, it transmits the RREQ packet by communicating it to its neighbors. Similarly, on the off chance that it has a course to the goal, it can send the RREP back to the source node by turning around the course data put away in the RREQ packet(Fig 2)



(a) RREQ Packet Floods in Network

(b) Unicasting of RREP Packet

Fig. 2.Route discovery process of AODV [16]

B. In the *Route Maintenance* stage, when node identifies a broken connection, then node sends a Route ERRor (RERR) message to source node advising that connection is broken. Right here and there, the source node either tries a substitute way accessible to destination or reinitiates the route disclosure handle. At the point when a moderate node that is incorporated into the packet sending process moves out of its communication extent of its upstream neighbor, broken connection occurs. (Fig 3)

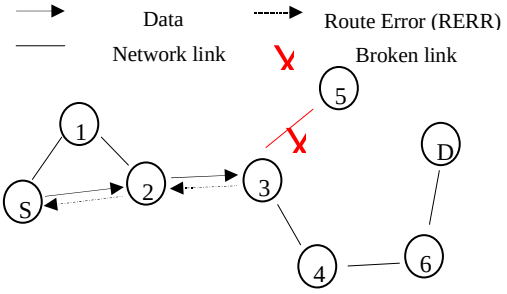


Fig 3. Route maintenance process of AODV [16]

V. BLACKHOLE ATTACK

Blackhole attackis a kind of MANET attack which is available in a system and go about as a truthful node yet the genuine importance of Blackhole assault is really a malignant node. Malicious node go about as manufactured node in the system and imagine like that it has the best wayto deliver the packet or says that it has the new route to the destination.

The source node communicates the Route Request (RREQ) packet and further sent the RREQ packet to middle of the road nodes for the inquiry of best and short way. In the event that the noxious node is available in the system and that malevolent node gets the RREQ packet, it's instantly sends false Route Reply (RREP) packet with high arrangement number. In this the manufactured (false) node asserts that it has the best way to deliver the packet to destination. At that point as opposed to sending the packet to destination, the false node drops that packet.

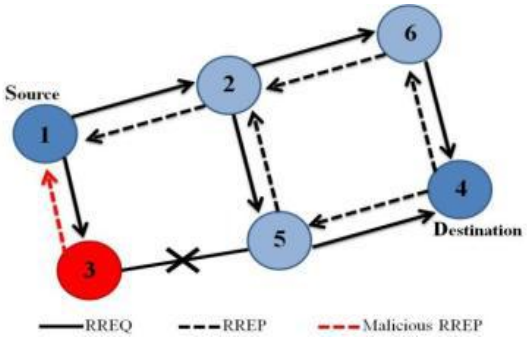


Fig 4. Blackhole attacks

In Fig 4 (Blackhole attack), node 1 is the source node and 4 is the destination node and node 3 is a noxious node who go about as an authentic node. At the point when a source node sends the Route Request (RREQ) packets to all nodes then most importantly, the malicious node answers to that RREQ packet and takes the packet from source and as opposed to sending the packet to destination node, the malevolent node drops the packet. The Blackhole assault is intense kind of assault that straightforwardly results on the end to end delay, packet delivery ratio and throughput.

VI. PROPOSED METHOD

Firstly, as soon as the source node wants to transmit an information, the source node requests for nearest Backbone node for a Requested IP (RIP). On accepting RIP from Backbone node, RIP responses to source node through any of the idle IP addresses and these idle IP addresses are chosen haphazardly. And at the same time, source node forwards the Route Request (RREQ) for destination as well as for Requested IP (RIP).

If Source Node (SN) gets the Route Reply (RREP) only for the destination node (this case is the typical case) and not for Requested IP (RIP), at that point we can say that the nearby system region is unrestricted from blackhole nodes. The source node reuses the RIP for an unmistakable timeframe for supplementary information communications. However on the off chance that the SN gets a RREP for the RIP, at that point it implies that there is a blackhole node in that course. For this type of condition, the SN starts the process for the discovery of blackhole nodes. Firstly, the SN alarms the adjacent of that nodes from which it has gotten the RREP to RIP, to go into unbridled mode. Presently the SN directs a false link information packets to the destination, while the nearby nodes initiates by observing the packet stream. Additionally, these type of nearby nodes transmits the screen message to the next bounce of the fake information packet and so on. At a moment that the checking nodes discovers that the spurious information packet misfortune is far more than the ordinary expected misfortune in a system, it educates the SN about this specific Intermediate Node (IN). Presently relying upon the data gotten by the different checking nodes, the SN distinguishes the area of the Black Hole. This data is proliferated all through the system prompting its posting as black hole and denial of their declarations. Assist all nodes disposes of any further reactions from this black hole and searches for a legitimate option course to the destination.

Proposed Algorithm

The Proposed Algorithm is divided into three phases:

A. Activities by Source Node (SN)

1. Source Node (SN) directs a Request to the Back Bone Node (BBN) for Restricted IP (RIP).
2. On getting RIP from BBN, at the same time it directs RREQ for destination as well as for RIP.
3. Awaits for RREP.

B. Activities by Intermediate Node/Destination Node

1. On getting RREQ it primarily creates a path in its Routing table for that node which forwards the RREQ.
2. Whether it is goal node or on the off chance that it has a sufficiently crisp path to the goal node, it replies with RREP to RREQ.
3. If this is neither goal nor it has a sufficiently crisp path to goal, then this advances RREQ to its adjacent nodes (also known as neighbors).
4. On getting RREP, it again makes an entry in its routing table which has send RREP and then sends RREP in the opposite path.
5. When it gets a request to come in uninhibited mode, it begins to listen for all those packets that are intended to specific IP address in the system and then it monitors its neighbors for the association of fake or dummy information packets.
6. In the event that, it determines that the false packet is outstandingly more than typical information packet at a definite node, it educates back the IP of this node.

C. Activities by SN on getting RREP (Blackhole Removal Process)

1. Certainly, If RREP comes from goal, the node does the usual working by conveying the information by the path.

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2. When RIP gets RREP, it initiates the procedure of blackhole detection, by forwarding a demand to go into unbridled manner to the nodes in a substitute way.
3. The input directed by the substitute ways are broke down to distinguish the dark gap and this data is transmitted all through the system, prompting the renouncement of the Black Holes records.

VII. METHODLOGY OF EVALUATION

A. Simulation Environment

The simulation is completed by NS-2 (v-2.35) network simulator to examine the performance of our proposed result in contrast to Blackhole nodes and Congestion. An area of 1000x1000, 10, 25, 50, 75, 100, 150, 200 nodes are randomly distributed, they uses virtual sensing area and compares the AODV routing protocol with or without the Blackhole attack along with the congestion. The malicious nodes that is blackhole nodes are also randomly distributed as that of the total no. of nodes in the network. Additionally, every node was moved in a Two Ray Ground Model. The simulation parameters are summarized in table 1.

TABLE 1. SIMULATION PARAMETERS

Parameter	Description/Value
Simulator	NS-2
Version	NS 2.35
Number of nodes	10,25,50,75,100,150,200
Antenna Type	Omni directional
Coverage Area	1000*1000
Simulation Time	700s
Mobility Model	Two Ray Ground Model
MAC Type	802.11 Mac Layer
Traffic Type	UDP-CBR
Routing Protocol	AODV(Reactive)
No. of Blackhole nodes	7
Channel	Wireless Channel
Max Movement Speed	1.5
Min Movement Speed	0.5

B. Metrics used for Simulation

For evaluating performance of our proposed approach, we have considered the various metrics:

1) Packet Delivery Ratio (PDR): PDR is the proportion of aggregate amount of information packets acknowledged by the goal nodes and an aggregate quantity of information packets created by the starting nodes. Henceforth, PDR demonstrates the total quantity of the information packets which achieve goaleffectively. Greater PDR demonstrates higher protocol execution.

*2) Throughput of the network:*It is the most extreme rate at which something can be prepared. Additionally, throughput or network throughput is the amount of successful delivery of message over a communication network.

3) End-to-End Delay: End-to-End Delay is characterized by way of the period passed by amongst the snapshot of directing of a bit by foundation node and the snapshot of this gathering by the goal node. It incorporates every conceivable postpones occupied by switch to look for the way in the system. The normal End-to-End delay is measured in milliseconds.

VIII. SIMULATION ANALYSIS AND RESULTS

A) Packet Delivery Ratio (PDR): Fig. 5 demonstrates the packet delivery ratio of Default AODV, AODV under black hole nodes (AODV-B) and our proposed AODV i.e. AODV-P when node mobility (no. of nodes) increases. It is clear from the figure that the performance of AODV-P is superior over AODV-B. The PDR of Default AODV under no attack is approximately on an average 99.94% for 10, 25, 50, 75, 100, 150, 200 nodes, and the PDR of AODV with Blackhole (7 blackholes) is approximately 6.12% i.e. reduced by 93.82% when compared with Default AODV while in Modified AODV i.e. Proposed AODV in the presence of multiple blackhole nodes is approximately 66.92%, increased by 60.8% when compared to AODV-B. So in this way the congestion is being controlled in proposed AODV.

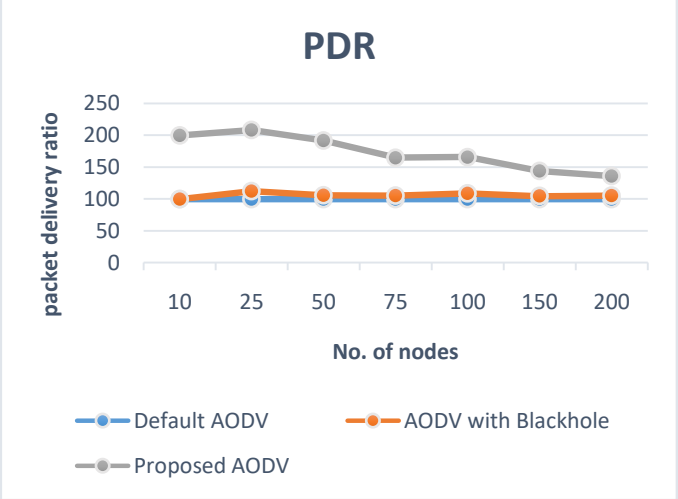

Figure 5: Packet Delivery Ratio v/s No. of Nodes

B) Throughput of the network: Fig 6 demonstrates the throughput of Default AODV (AODV-D), AODV under black

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hole nodes (AODV-B) and our proposed AODV i.e. AODV-P when node mobility (no. of nodes) rises. Fig 6 is clearly showing that the performance of our approach is superior over AODV under blackhole nodes. The throughput of Default AODV under no attack is approximately 29.34% for 10, 25, 50, 75, 100, 150, 200 nodes (on an average), and the throughput of AODV with Blackhole (7 blackholes) is approximately 1.60% i.e. reduced by 27.74 % when compared with Default AODV while in Modified AODV i.e. Proposed AODV in the presence of multiple blackhole nodes is approximately 23.18%, increased by 21.18% when compared to AODV-B.

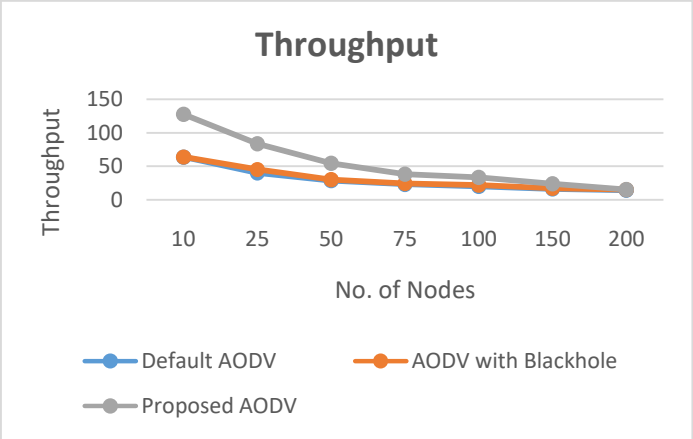

Figure 6: Throughput v/s No. of nodes

C) Average End-to-End Delay: Fig 7 shows the Average End-to-End Delay of AODV v/s No. of Nodes when there is no blackhole node (AODV-D), when there are seven blackhole nodes (AODV-B), and our proposed AODV (AODV-P). Fig 7 clearly shows that the performance of our proposed approach (AODV-P) is superior over AODV-B.

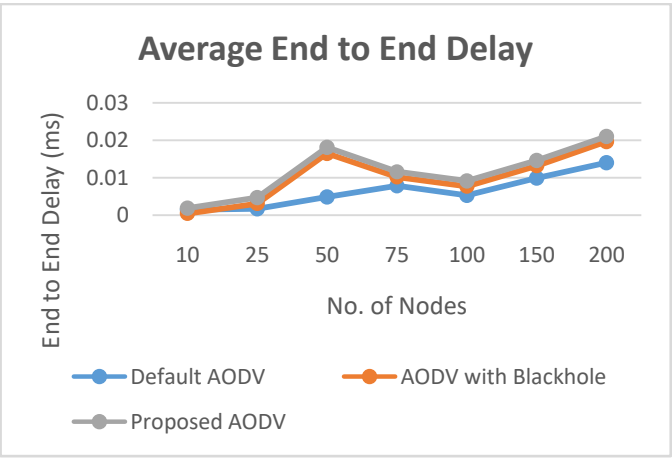

Figure 6: Average End to End Delay v/s No. of Nodes

D) Calculation of the Number of the Packets Send, Received and Dropped by the Blackhole nodes in AODV-D and AODV-P: We have examined the amount of the number of packets directed without any blackhole node and with seven blackhole nodes in the default AODV routing protocol and also in our proposed AODV, as shown in Fig. 7, Fig 8, and Fig 9. The number of packets moving in the network are 58697 packets (on an average) in AODV-D, AODV-B and AODV-P. The number of packets received 58676 packets (on an average) in AODV-D, 3197 in AODV-B and 46352 in AODV-P. The number of packets dropped over the network are 20 packets (on an average) in AODV-D, 55499 in AODV-B and 12344 in AODV-P From the simulation, we certainly emphasize that our proposed approach has overcome the blackhole attacks.

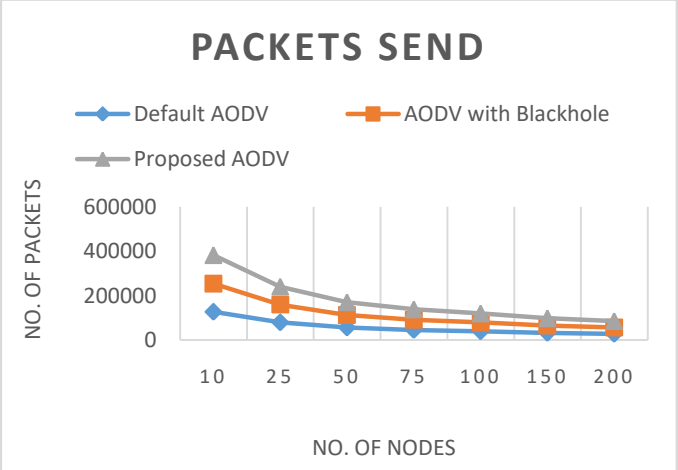

Figure 7: Total No. of packets send v/s mobility nodes

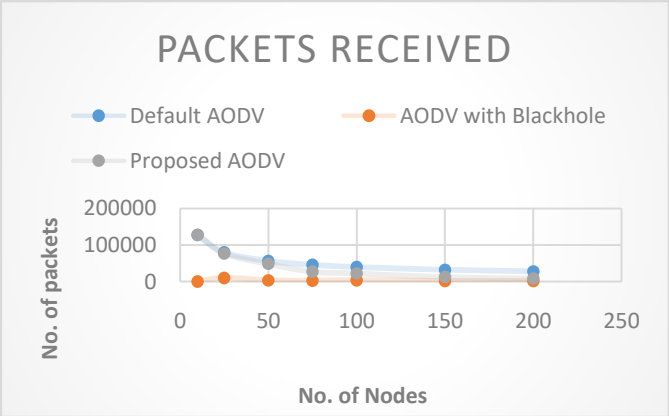

Figure 8: Total No. of packets received v/s mobility nodes

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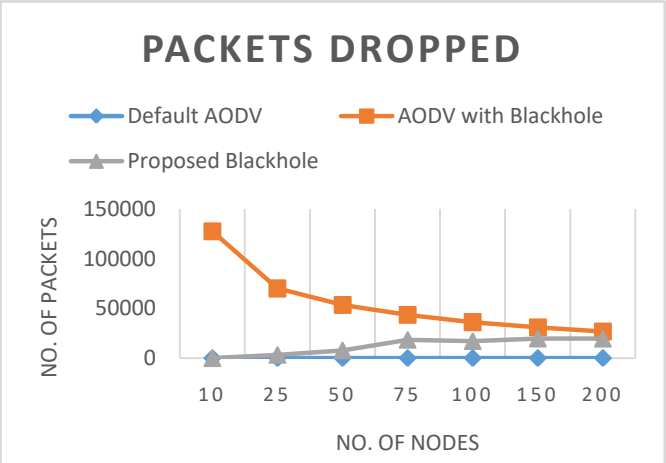

Figure 9: Total No. of packets dropped

IX. CONCLUSION

As we have examined that the Ad hoc routing protocols are disposed to many assaults because of an aspect of unawareness of the security for the duration of their strategies. During route discovery process, the standard functionality of network can be interrupted by blackhole assaults by forwarding fake routing details. We have proposed an elucidation to avoid the multiple blackhole nodes on AODV and selection of optimal path to escape congestion in the system. Accordingly, the simulation results for the proposed AODV provides substantial enhancement in packet delivery ratio (PDR) using adequate average end-to-end delay and throughput, when the no. of nodes rises. The route discovery process is exaggerated by the intrusion and modifying the carrier sensing range due to the effect of virtual carrier sensing on the AODV routing protocol and concepts of dummy packets.Subsequently, we have determined that our proposed AODV (AODV-P) shows higher performance than AODV with blackhole (AODV-B) and avoids congestion in the network.

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