Improved Cost Efficient AODV Routing Protocol

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Abstract— AODV (Ad-Hoc On-Demand Distance Vector) is a reactive routing protocol for mobile Ad- Hoc networks (MANETs) and other wireless ad-hoc networks. Reactive means that it establishes a route to a destination only on demand. The cost is one of the most important network performance parameter. In the paper, the conventional AODV is compared with proposed Improved Cost efficient AODV routing protocol using Euclidean distance. The route with shortest Euclidean distance is selected for communication. The proposed AODV routing protocol thus helps to overcome the factors like End to End Delay, Packet Loss and Network Routing Load which generally occurs in conventional AODV routing protocol due to changing topology of the network.

Keywords— AODV, Cost, End-to-end Delay, Metric

INTRODUCTION

MANET is a collection of wireless nodes [9] that can dynamically be set up anywhere and anytime without using any pre-existing network infrastructure [11].AODV is a mainly used for wireless network where nodes are not stationary. AODV is the on-demand routing protocol [1] [3]. Routes, in AODV protocol, are established based on minimum hop count [15]. Routes are established in AODV Routing Protocol when it requires to send the data from source. So the AODV routing protocol is called as reactive routing protocol. The cost of network is one of the important parameter. Secondly the reliability of network also plays the vital role. The cost efficient network requires to satisfy the various network performance constraints such as energy consumption, End-to-End delay, Packet loss and Network Routing Load. The energy consumption depends upon the efforts taken by source node to circulate the data among intermediate node till it reaches to the destination. The energy consumption varies with the distance among the nodes .If the distance between the nodes is large the energy consumption will automatically rise or vice versa .The energy consumption directly affect the cost of the network. End-to-End delay is time required by the information to travel from the source node to destination node. Delay will engage the node in the network for large time and thus increase possibility of the hop count as well power consumption. This delay in return affects the cost of the network. The Packet loss occurs when the source node sends data to destination node which is placed at long distance or there may happen the link failure during communication**.**

The rest of this paper is ordered as follows. The Section 2 represents working of AODV routing protocol and related works are discussed in Section 3. Section 4 gives the idea regarding the Euclidean distance concept; Section 5 explains the proposed Method and Section 6 gives detail of simulation results and its discussion .The Section 7 provides the conclusion and future work whereas Section 8 represents References.

WORKING OF AODV PROTOCOL

In AODV routing Protocol the source node floods the Route Request packet in the network when a route is not available for the desired destination. It may obtain multiple routes to different destinations from a single Route Request. Routes, in AODV protocol, are established based on minimum hop count [13]. The exceptional thing in the AODV protocol is that it uses the DestSqnNum to update the path.
There are various types of messages are used in AODV routing Protocol

a) **Route Request (RREQ) message:** It is used to form a route from one node to another node in a network.
b) **Route Reply (RREP) message:** It is used to connect destination node to source node in a network.
c) **Route Error (RERR) message:** It is used to indicate any route broken or node failure.
d) **HELLO message:** It is used to determine the activeness of the network. The transmission of data depends on route discovery and route maintenance in AODV. The route discovery depends on RREQ and RREP messages, if a node initiate's request of

route it will form route after getting the RREP. The route will be maintained by sending HELLO messages to neighbour nodes, if any link failure it will indicate using RERR message.

The Routing Mechanism in AODV comprises of two main processes i.e. route discovery and route maintenance.

Route Discovery Process:

When source node tries to send a message to a destination node without knowing an active route to it, the sending node will initiate a path discovery process. A route request message (RREQ) is broadcasted to all neighbors, which continue to broadcast the message to their neighbors and so on. The RREQ forwarding process is continued until the destination node is reached or until an intermediate node knows a route to the destination that is new enough. In order to keep loop-free and most recent route information, every node maintains two counters: sequence number and broadcast_id. The broadcast_id and the address of the source node uniquely identify a RREQ message. The broadcast_id is incremented for every RREQ the source node initiates. An intermediate node can receive multiple copies of the same route request broadcast from various neighbors. In this case if a node has already received a RREQ with the same source address and broadcast_id it will discard the packet without broadcasting it anymore. When an intermediate node forwards the RREQ message, it records the address of the neighbor from which it received the first copy of the broadcast packet. This way, the reverse path from all nodes back to the source is being built automatically. The RREQ packet contains two sequence numbers: the source sequence number and the last destination sequence number known to the source. The source sequence number is used to maintain "freshness" information about the reverse route to the source while the destination sequence number specifies what actuality a route to the destination must have before it is accepted by the source. When the route request broadcast reaches the destination or an intermediate node with a fresh enough route, the node responds by sending a unicast route reply packet (RREP) back to the node from which it received the RREQ. So actually the packet is sent back reverse the path built during broadcast forwarding. A route is considered fresh enough, if the intermediate node's route to the destination node has a destination sequence number which is equal or greater than the one contained in the RREQ packet. As the RREP is sent back to the source, every intermediate node along this path adds a forward route entry to its routing table. The forward route is set active for some time indicated by a route timer entry. If the route is no longer used, it will be deleted after the specified amount of time. Since the RREP packet is always sent back the reverse path established by the routing request, AODV only supports symmetric links.

Route Maintenance Process:

Route maintenance can be accomplished by two different processes

- Hop-by-hop acknowledgement at the data link layer
- End-to-end acknowledgements

Hop-by-hop acknowledgement is the process at the data link layer which allows an early detection and retransmission of lost packets [7]. If the data link layer determines a serious transmission error, a route error packet is being sent back to the sender of the packet. The route error packet contains the information about the address of the node detecting the error and the host's address which was trying to transmit the packet. Whenever a node receives a route error packet, the hop is removed from the route cache and all routes containing this hop are truncated at that point. When wireless transmission between two hosts does not process equally well in both directions, end-to-end acknowledgement may be used. As long as a route exists, the two end nodes are able to communicate and route maintenance is possible. In this case, acknowledgements or replies on the transport layer used to indicate the status of the route from one host to another. However, with end-to-end acknowledgement it is not possible to find out the hop which has been in error.

RELATED WORK

AODV is reactive routing protocol. It is simple, efficient and effective routing protocol having wide application [14]. The topology of the network in AODV gets change time to time. As a result of this, maintaining the Cost, End-to-End, Packet Loss and Network Load is a great challenge. Various researches have been carried out on above factors. Tooska D. [16] had presented a semi-proactive routing protocol (SP-AODV) based on a reactive AODV protocol. In SP-AODV protocol, all nodes use AODV routing protocol to find a path to a destination. The results showed that SP-AODV routing protocol has more packet delivery ratio and fewer end-to-end delay compared to AODV. They also observed that control packet overhead in SP-AODV is less than AODV in low and medium mobility of nodes; but it is more than AODV in high mobility of nodes. Sujata et.al. [12] had done the comparison of AODV and RAODV routing protocols. In RAODV they had changed route replay packet configuration of AODV and named it RRREQ. The simulation results of RAODV are better than other version of AODV algorithm. In future they will work on energy concept in RAODV, so that they can assign the priority of different dedicated paths between source and destination on the basis of both energy as well as the stability of nodes or paths. P. Parvathi [10] had done the comparative analysis of CBRP, AODV and DSDV. They observed that DSDV routing protocol consumes more bandwidth, because of the frequent broadcasting of routing updates and AODV is better than DSDV as it doesn't maintain any routing tables at nodes which results in less overhead and more bandwidth. While Compared with AODV, CBRP overhead is lower and its throughput is considerably higher. Mohammad S. [7] had studied the AODV routing protocol and black hole attack. They proposed the method to prevent the malicious packet dropping by considering the number of neighbor of each and every individual node. Also, they have shown that, the right place to validate the RREP which it is sent by an intermediate node should be the first node in the reverse path, to avoid propagating false route information in the network. In future they would like to extend the proposed scheme for detecting the wormhole attack. Manoranjan D. et.al. [6] had observed from the detailed analysis that the packet delivery fraction for the MANET with higher load is less than lower load. The cause of lower packet delivery fraction at higher load is high packet drop at network interface due to overflow. They also observed that the routing load for network with higher load is higher than the network with lower load. The number of link breaks is higher at lower pause time but the packet delivery is better at lower pause time due to the ability of the nodes to get alternate path..Li Y.et.al [5] had done a nonlinear dynamic optimization for route discovery phase of AODV through simulation and analysis Packet delivery ratio, average end to end delay, routing load, packet loss rate. The results show that the improved AODV routing protocol enhances node's data forwarding capability while reducing the routing load and packet loss rate. The protocol is not perfect because of limit time. Kishore B. et.al. [4] had proposed improved protocol PWAODV based on piggyback mechanism and they introduced weighted neighbor stability. The path selected in protocol is more stable and effective. It also reflects the mobility of nodes accurately. Finally, the advantage reflected in the simulation results is brought by reducing transmission of redundant packets and improving the robustness of the route. The direct result is that the performances of route cost and end-to-end delay have been improved greatly. Moreover, when compared with using the GPS auxiliary hardware or the cross-layer thought it can avoid many problems. Hemant G. et.al. [2] had done discussion of how routing load and packet loss in AODV protocol can be minimized in any given network. They had developed technique which identify the broken link between any two nodes and also repaired the same or route can be discarded from the network to avoid loss of packets. M. Usha et.al. [8] had proposed an enhancement of AODV routing protocol. They named new protocol as RE-AODV (Route-Enhanced AODV). They take routing overhead and end-to-end delay as QoS parameters. TOSSIM simulator is used for performance evaluation. When the routing overhead is evaluated for RE-AODV and it is found to be 25% less compared to AODV. Moreover end-to-end delay of packets from source to destination in RE-AODV reduced by 11%, as against AODV. In future, they will work on energy efficiency parameter of AODV.

EUCLIDEAN DISTANCE CONCEPT

The network with nodes A,B,C,D,E,F is given in figure 1. Consider the Euclidean space for two dimension.

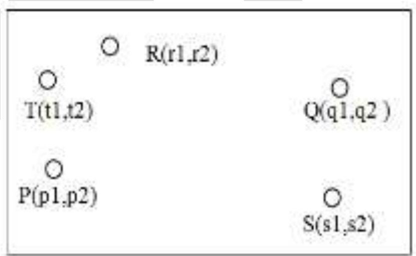

Figure.1 Scenario of a wireless Network with Mobile nodes

Consider the two dimension Euclidean space. When the node P has to send the data to the Q, then first of all the P will check the Euclidean distance of the nearby nodes. The path which can be followed to send the data may be P-T-R-Q, P-S-Q, P-R-Q or P-Q. First of all AODV has to calculate the Euclidean distance for all possible path then require to follow the path with small metric i.e. Euclidean distance . In order to find the Euclidean distance between two nodes P and Q , first of all P and Q are described with coordinates (P1,P2) and (Q1,Q2) respectively . In first step length between the P and Q is given by |P1 - Q1| and |P2 - Q2|.Secondly the Pythagorean Theorem is between the two length gives ((P1 - Q1) ^2 + (P2 - Q2) ^2) ^ (1/2). So the distance between two points P

= (P1, P2) and Q = (Q1, Q2) in two dimensional space is there given as . Through the calculation of Euclidean distance it is easy to calculate the power consumption, End- to -End delay and the number of hop required. Large the Euclidean distance more power will get consumed, End-to-End delay will increase and the number of hop will increase indirectly the net cost of the network gets increase. Similarly if Euclidean distance is less the net cost of the network gets reduce.

PROPOSED METHOD

The working of proposed improved cost efficient AODV routing protocol using Euclidean concept is given below. Consider the figure 1 given above for the proposed AODV protocol scheme .In the figure1 P,Q,R,S,T are the nodes in the network. The number of Nodes (N) are responsible for size of the network. S is the source node and D is the destination node. In network if P is the source

Node (S) and Q is the destination Node (D). The data is send from S to D with the help of nearby Nodes (Nn) and using the AODV protocol based on Euclidean Distance (Ed) concept. Later on the Cost(C) of the network is calculated. The algorithm of the proposed method is given below.

Step 1: Set N

Step 2: Define S and D

Step 3: Set the AODV protocol.

Step 4: Calculate the Ed between S & Nn.

Step 5: Send data from S to D by using Nn with small Ed.

Step 6: Suppose the 'T' is placed at small Ed from S i.e P, then follow the path P → T, then T will be the S. This will continue till data reach to D i.e Q.

SIMULATION RESULTS AND DISCUSSION

The simulation is done using Network Simulator 2.35. The network performance parameters such as cost, End-to-End delay, Packet Loss and Network Routing Load are evaluated against number of communications or data transfers for both conventional AODV and Improved Cost efficient AODV Routing protocols and are shown below. The blue colour curve represents the conventional AODV protocol while the Red colour curve represents the proposed improved AODV protocol. The Simulation Parameters are given below.

Parameter	Value
Simulator	NS2.34
Simulator Time (s)	50 seconds
Number of Nodes	20,40,60
Simulation Area	500*500
Routing Protocol	AODV
Traffic	CBR (UDP)
Channel Capacity	1 M Bits/sec
MAC Layer Protocol	IEEE802.11
Transmission Range	1.5 Meters

Table I. Simulation parameters

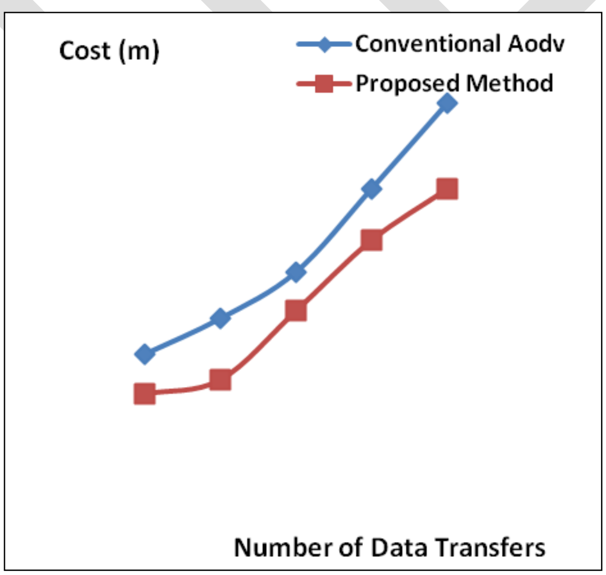

Figure 2 Comparison of Cost for 60 Nodes

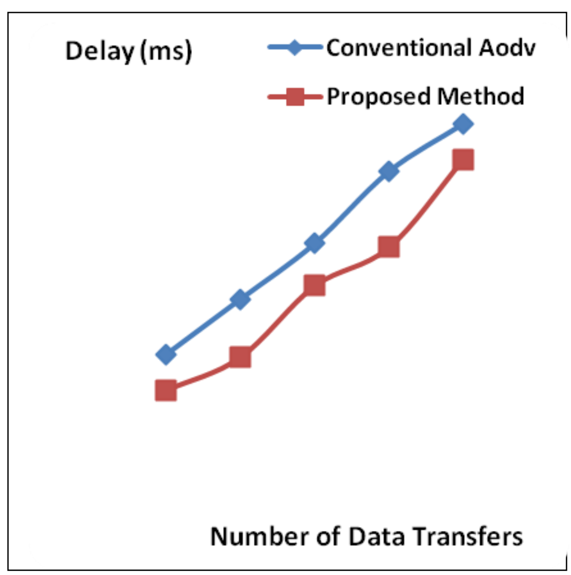

Figure 3 Comparison of End-to-End Delay

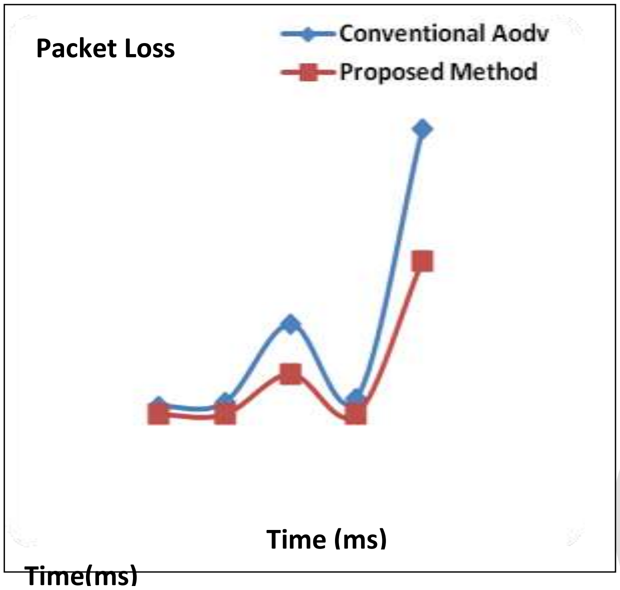

Figure 4 Comparison of Packet loss

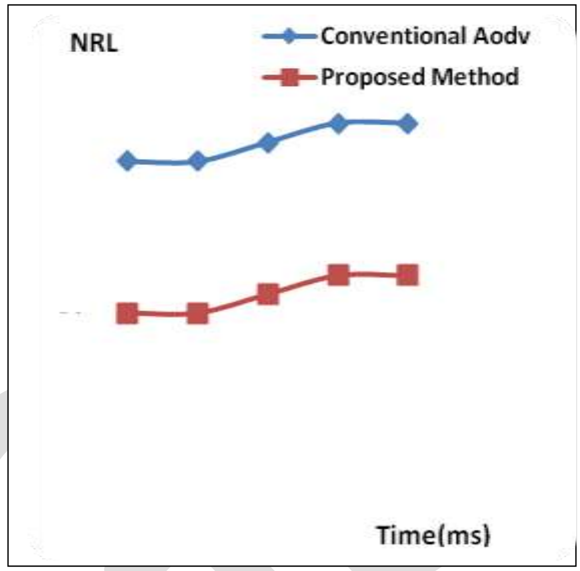

Figure 5 Comparison of NRL

Figure 5.1 Comparison of Cost for 60 Nodes

- Cost is the amount of energy consumed .It also depends on number of nodes utilized, and packet loss. Energy consumption varies with the Euclidean distance .Larger the distance between the nodes more will be energy consumption or vice versa. In figure 2. Number of Data transfers is plotted against the cost. In the graph five data transfers are consider. It is observed that cost of proposed improved cost efficient AODV routing is very less as compare with conventional AODV. Cost in proposed AODV simulation touches the lowest level by reducing the distance and follows the shortest path of 1300 meters.

- End-to-End Delay means the delay; a packet suffers between leaving the sender application and arriving at the receiver application. This metric represents average end-to-end delay and indicates how long it took for a packet to travel from the source to the application layer of the destination. It is measured in seconds. In figure.3 the Number of data transfers is plotted against the delay. It is observed from graph that Proposed AODV has reduced the End-to-End Delay as compare to the conventional method.

- Packets Dropped: The dropped packet count is the number of data packets that are collided or crashed during the data transmission between source and destination.In figure.4. The Number of data transfers is plotted against Packet loss. It is observed from graph that Proposed AODV has low packet loss as compare with conventional AODV routing Protocol.

- Normalized routing load is the number of routing packets "transmitted" per data packet "delivered" at the destination. Each hop-wise transmission of a routing packet is counted as one transmission. In figure.5 the Number of data transfers is plotted against Network Routing Load. It is observed from graph that Proposed AODV has negligible network routing load in all data transfers as compare to conventional AODV routing protocol.

CONCLUSION AND FUTURE WORK

The performance metrics such as Cost, Delay, Packets Loss and Network Routing Load are evaluated against number of data transfers for both conventional AODV and improved cost efficient AODV protocol with number of mobile nodes of up to 60 using NS-2.35. It is observed even though if numbers of nodes are increased, still the improved cost efficient AODV protocol performs well and yields better throughput level with less delay and consumes less energy. Despite having high Network load the proposed AODV is able achieve less packets Drop when compared to conventional AODV protocol. In this simulation the proposed AODV protocol has best all-round performance. In future same work can be extended by introducing the security parameter to avoid wormhole attack .Secondly the performance comparison of AODV with other routing protocols can be also carried out to judge the performance of the work.

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