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AN IMPROVED AODV ROUTING PROTOCOL FOR MOBILE AD-HOC NETWORKS

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ABSTRACT: Mobile Ad-hoc Network (MANETs) is self-configuring network of mobile nodes connected by wireless links. Self-configurability and fast deployment feature of the MANET makes it most attractive choice for users. Routing in such networks is a key issue which decides network performance. Ad Hoc On-Demand Distance Vector (AODV) is one of the widely used reactive routing algorithms. Energy consumption and delay are the main concern for a number of researchers. Due to unbalanced node usage, some of the battery powered nodes drain out faster than others. This leads to route re-discovery causing larger average end to end delay and more control overhead. In this paper we are presenting an improved AODV (I-AODV) protocol. The proposed protocol introduces a stability factor which conserves and stabilizes energy among the nodes, and a delay reduction mechanism which reduces the average end-to-end delay of the network. NS-2 simulator is used to compare performances of AODV and I-AODV. Simulation results are observed for wireless network scenarios with variation of node mobility, pause time, network area and packet sent rate. The results show that the energy consumption and end to end delay in mobile scenarios decreases significantly, without much affecting the other QoS parameters. In addition proposed protocol improved packet delivery.

Keywords: MANET, AODV, Energy consumption, Average end-to-end delay, Packet delivery ratio (PDR)

I.INTRODUCTION

One Ad hoc is a Latin word meaning “no fixed -establishment network” or “self-organize network”. In Ad hoc network, each mobile terminal can perform the function of router as well as a host computer. MANET has received a great deal of attention because it can be quickly deployed in many scenarios in the absence of any fixed infrastructure [1]. Ad hoc networks could be generally classified to high mobility and low mobility networks. Low mobility networks are one in which nodes do not move frequently and with fast speed. Whereas high mobility networks are having nodes which move frequently and the topology changes are more.

A lot of routing protocols have been proposed for ad hoc networks [2]. These routing protocols are classified as table driven or proactive, on demand driven or reactive and hybrid. Table driven protocols perform well in static scenarios. Some examples of table driven routing protocols are Destination- Sequenced Distance-Vector Routing Protocol (DSDV) [3], Wireless Routing Protocol (WRP) [4], and Optimized Link State Routing (OLSR) [5]. Table driven protocols can become expensive in terms of routing load in ad hoc networks, because each node in the network must maintain routing information for every other network node. On demand driven protocols show high performance in dynamically changing environments. Some examples of these protocols are DSR [6] and AODV [7]. On demand driven protocols outperform table driven protocols in terms of routing load, packet delivery ratio, and energy efficiency in ad hoc network.

In AODV, an on-demand dynamic routing protocol, when a source node needs to send data but has no valid route in its route table, it initiates the route discovery process. In route discovery, the source node broadcasts a route request (RREQ) to its neighbors. An intermediate node receiving a RREQ first sets up a reverse path to the source node if needed. If the intermediate node has a valid route to the specified destination, or it is just the destination node, it returns a route reply packet (RREP) to the source node. Otherwise, the node will broadcast the RREQ to its neighbors. As the RREP travels towards the source, a forward path to the destination can be established. When the next hop link breaks, RERR packets are sent to a set of neighboring nodes that communicate over the broken link with the destination. AODV minimizes the routing table. However, AODV can gather only a limited amount of routing information; route learning is limited only to the source node. This usually causes AODV to rely on a route discovery flood more often, which may carry significant network overhead [5].

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The rest of the paper is organized as follows; Section II explains the proposed protocol I-AODV. Section III shows Simulation results and analysis. Section IV concludes the paper and Section V gives the future scope.

II.PROPOSED PROTOCOL (I-AODV)

Various techniques have been proposed to incorporate a stable and reduced energy consumption and minimization of end to end delay in the network individually. There is need for considering a technique for improvement of energy consumption in the existing AODV protocol and also reduced the delay in the network.

The proposed protocol I-AODV is similar to AODV with some additional constraint on route discovery process. Generally in AODV, during route discovery process the remaining energy of node is not considered. Therefore nodes that have low energy level will die down early and that will result into more number of link breaks. In I-AODV protocol, Stability factor is used to keep track of the remaining energy of node in the network. The Stability factor of a node is defined as the ratio of its remaining energy to the initial full energy [8].

Stability Factor (SF) = *Remaining Energy of node / Initial full Energy of node* (1)

Node in the network decides whether to act as router or not depending on this stability factor. Hence, there is no need to pass its value to neighbours through any of the control messages. In original AODV protocol, whenever a node receives a RREQ message it is processed without considering its energy level. In I-AODV, when a source node sends a RREQ message and it reaches to its neighbouring node, then that node first checks its stability factor.

If its factor is higher than threshold then only it will process the RREQ message. Due to this node saves its energy in processing of RREQ also. So this modification put a limit on how to broadcast a RREQ and who should participate in forming a route from source to destination. With consideration of this factor, energy consumption of the nodes as well as link failure of network decreases and the network lifetime increases.

In order to reduce end to end delay, the proposed I- AODV protocol uses three modifications. An improved ad hoc routing mechanism for finding a quicker path between source and destination, decreased RREP wait time during the back-off and the predefined time to live (TTL) threshold value has been modified. AODV Protocol uses Expanding Ring Search (ERS) for route discovery operation. I-AODV uses the modified ERS for fast route discovery.

The source node starts broadcasting the RREQ message with TTL=1. If the destination is not present in one hop range and nodes in one hop range does not have route to destination. Then TTL is increased by TTL increment of 2 i.e. radius of ring search 3. If the destination is still not found, the source node again increases TTL by 2 and broadcast the RREQ. AODV provides 3 retries for RREQ. Finally, TTL is set to a network diameter and the RREQ message is broadcasted to entire network. Finally destination receives the RREQ message and it acknowledges source by sending a Route Reply (RREP) message via same path. The modified ERS mechanism for quick route discovery is used in I-AODV where the TTL increment is set to 3. So ring search covers the more number of nodes in fewer attempts and reduces the unnecessary delay in the network.

In the original AODV, to reduce congestion in a network, repeated attempts by a source node at route discovery for a single destination utilizes a binary exponential backoff. The first time a source node broadcasts a RREQ, it waits net traversal time milliseconds for the reception of a RREP. If a RREP is not received within that time, the source node sends a new RREQ. When calculating the time to wait for the RREP after sending the second RREQ, the source node uses a binary exponential backoff. Hence, the waiting time for the RREP corresponding to the second RREQ is 2 * net traversal time. In the proposed I-AODV protocol, following equation is used to calculate the wait time.

Wait time = 3/2 * Net traversal time (2)

The equation (3) is used in proposed protocol to calculate wait time after first time RREQ flooded in network. This reduces unnecessary delay in the network. In a situation of no route found toward destination within calculated time period, the value for TTL is increases by 3 and the RREQ is flooded in network. Now, the wait time is calculated by multiplying 3/2 to the equation (2) for remaining broadcast. The process continues till the destination is found and a RREP is sent back to the source node.

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The predefined TTL threshold has also been modified which can substantially decreases the average delay for medium sized networks. The performance with a time to live threshold around 9-10 showed exceptionally good results for the delay performance. Performance is enhanced with small increase in threshold value for medium sized network as the probability of storing stale routes will be much less and number of new RREQ message generated to reach destination will also be less. The techniques used for the modification of the existing protocol will reduce the energy consumption of the nodes as well as the end to end delays in the networks during the data transmission processes. The flowchart of the proposed modifications is given below.

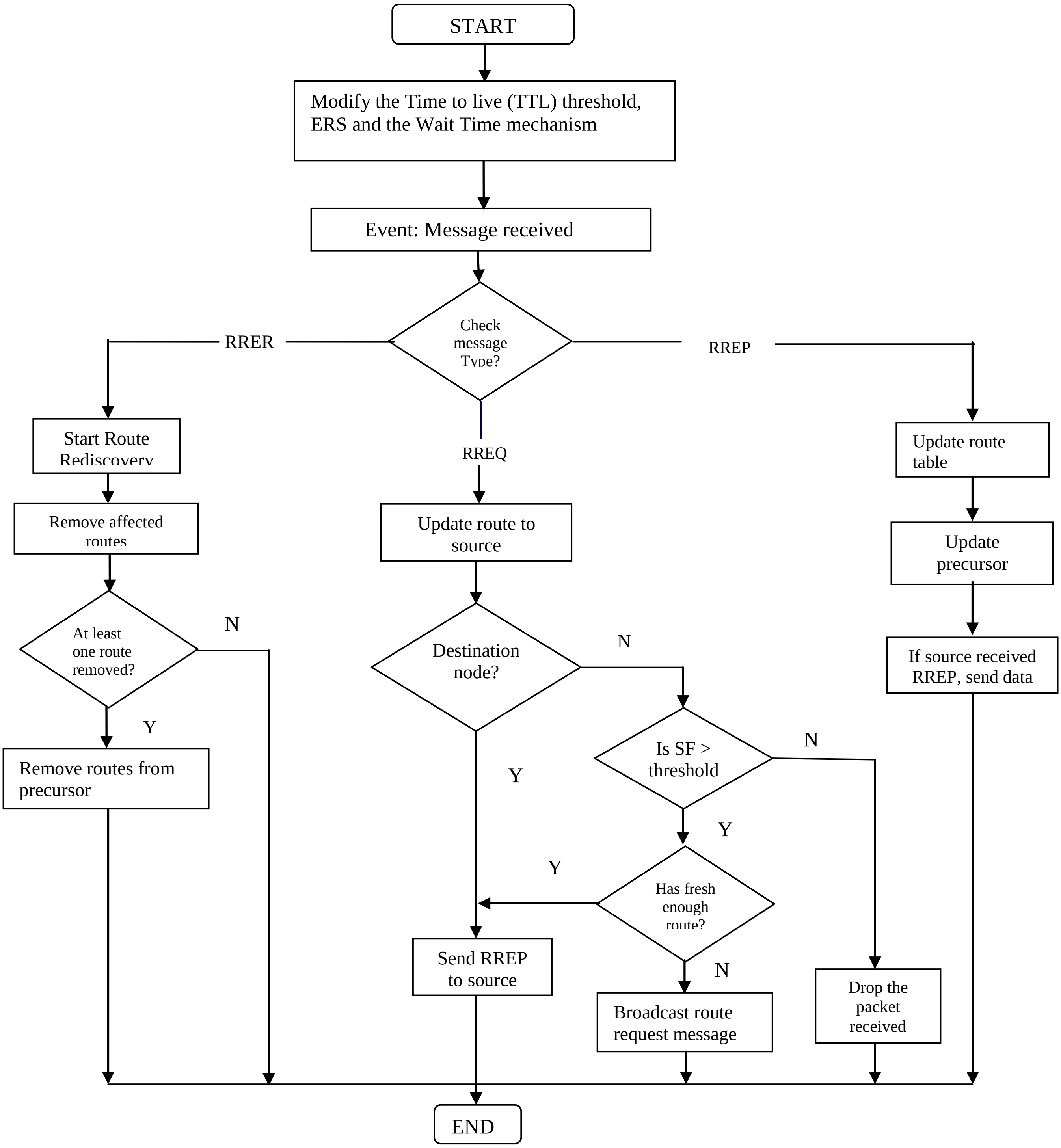

Fig 1.Flowchart of the proposed protocol I-AODV

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III.SIMULATION RESULTS AND ANALYSIS

All simulations are done on Network Simulator 2 (NS2). This simulator provides a comprehensive environment for designing protocols, creating and animating network scenarios, and analysing their performance. Various scenarios are examined for protocol's effectiveness in order to improve the quality of service (QOS) parameters.

Simulations of proposed method were carried out according to nodes and environment characteristics in different scenarios and variations:

A. Packet size variation

In this simulation, packet sizes are varied from 64 to 1024 bytes. Number of nodes is considered 100 and simulation area is kept 1000m×1000m. Nodes speed is kept at 1 m/s.

- *Energy Consumption*

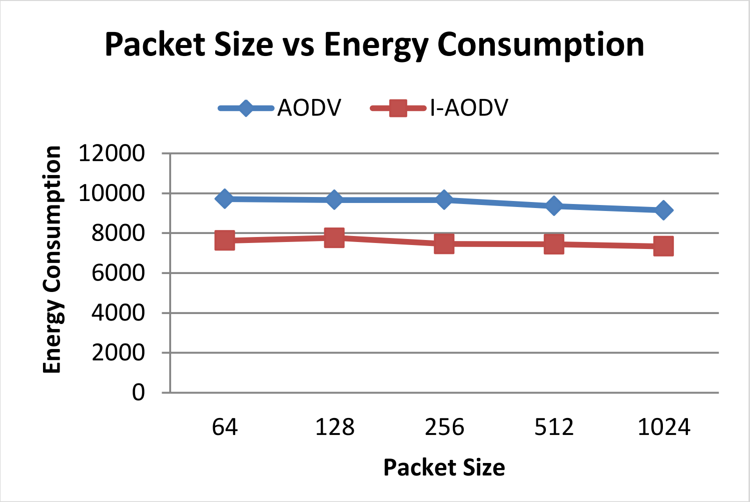

Fig.2: Packet size vs. Energy consumption

Fig.2 shows that the energy consumption is less for all the packet sizes. Energy consumption significantly reduces for the all the packet sizes sent from source to destination. The proposed protocol has typical lower energy consumption than the original AODV protocol.

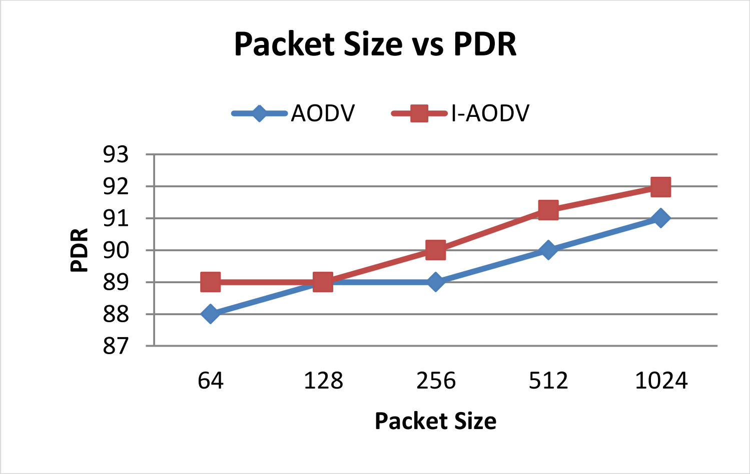

Fig.3: Packet size vs. Packet delivery ratio

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Fig.3. shows the packet delivery ratio comparison of the two protocols. The PDR of the proposed protocol is higher than the existing AODV protocol and the ratio is above 89% in all the packet sizes. The PDR increases continuously with increase in the packet size. Thus the proposed protocol is effective for larger packet sizes.

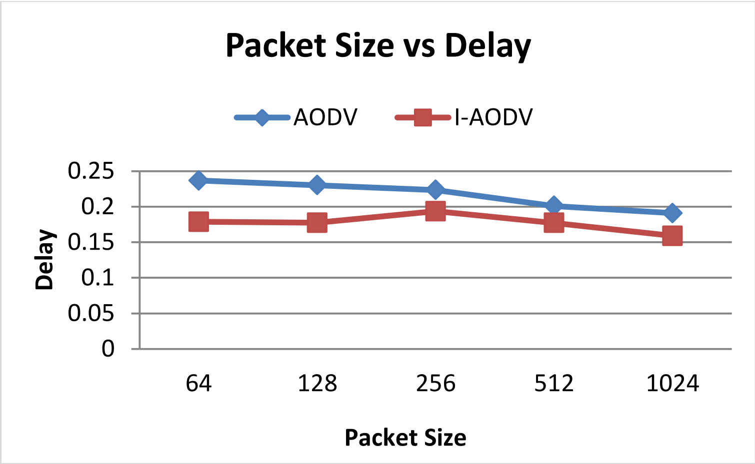

Fig.4: Packet size vs. End to end Delay

Fig.4 shows the comparison of the two protocols for the end to end delay in the network. The proposed protocol performs well for all the packet size variation than the existing protocol with decrease in delay substantial for all the packet sizes.

B. Node Speed variation

In this simulation, the speed of the node was varied from 0-20 m/s. The number of nodes was kept 100 in the simulation area of 1000*1000 square meters. The packet size was kept 1024 bytes.

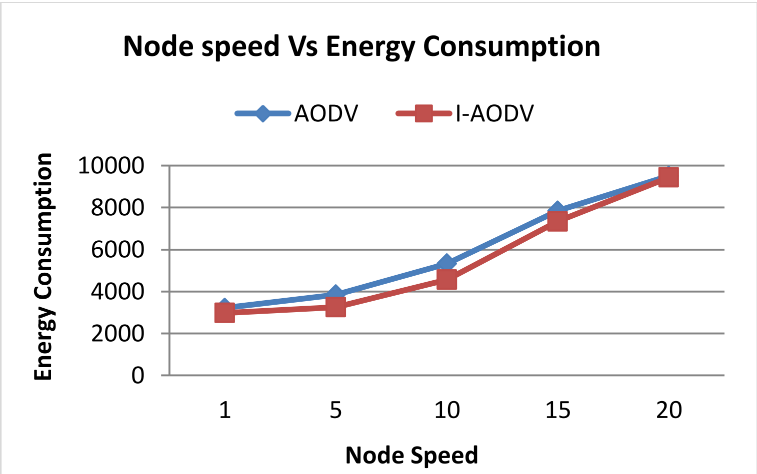

Fig.5: Node Speed vs. Energy Consumption

Fig.5 shows the energy consumption for both the protocols when the speed of the nodes are varied. The energy consumption of the both the protocols increases with increase in the speed but the consumption of the proposed protocol I-AODV is less than that of AODV. The decrease is significant near the range of 5-10 m/s. The packet delivery ratio of both the protocols were found to be well above 89%.The variation of the proposed protocol was within 1- 2% of the existing protocol.

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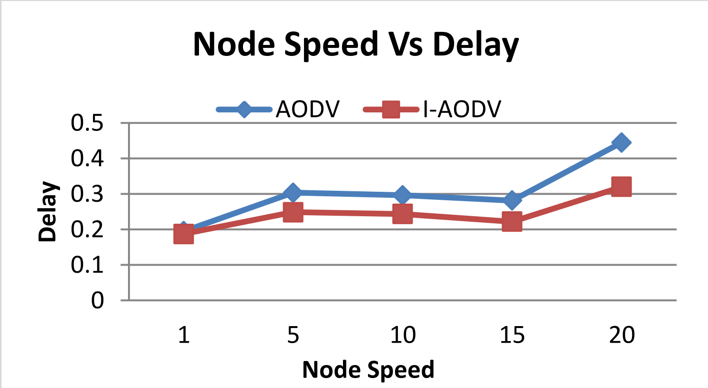

Fig.6: Node Speed vs. End to end delay

Fig.6 shows the end to end delay comparison of both the protocols. The delay of the proposed protocol was found to be less than the AODV protocol. The delay of both the protocols increases with increase in the node speed. The proposed I-AODV performs significantly for mobile and dynamic networks.

IV.CONCLUSION

This paper proposes the I-AODV routing protocol for MANETs that effectively reduces the energy consumption and the end to end delay during the route discovery process. It is observed that by using these techniques in routing protocol we are able to reduce the energy and end to end delay by about 7% to 24%. The protocol performs exceptionally in packet delivery ratio while maintaining the other quality of service parameters. Hence I-AODV is useful for applications in which nodes are mobile and packets of varying sizes are to be sent. The overall performance of the proposed protocol over the existing protocol is improved.

V.FUTURE SCOPE

Energy consumption of network can be reduced by decrementing the transmission power of the nodes depending on the minimum distance required for communication and energy level of node. This modification can further improve the existing protocol.

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