International Journal of Computer Information Systems,
Vol. 4, No.1, 2012

Simulation Study on Improved AODV Routing Protocol

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***Abstract*— Mobile Ad-hoc Network (MANET) is a network of wireless mobile nodes which communicate with each other without any centralized control or established infrastructure. Routing is a critical task in MANET where the nodes are mobile. In this paper an attempt has been made to evaluate the performance of prominent routing protocol of MANET: Ad-hoc On-Demand Distance Vector Routing (AODV) and Improved Ad-hoc On-Demand Distance Vector Routing (I-AODV) protocol. The performance differentials are analysed using various metrics like throughput, average end-to-end delay, total bytes received and average jitter.**

Keywords- AODV, End-to-end delay, Reactive routing, Throughput, Jitter.

I. Introduction

Mobile Ad-hoc Network (MANET) is a decentralized wireless ad-hoc network. The network is ad-hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. MANET is a self-configuring network of mobile nodes connected by wireless links; the union of these forms an arbitrary topology. The participating nodes act as routers if they are along the path to the destination. These are free to move randomly and manage themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion or may be connected to the larger Internet [1]. The MANETs working group (WG) within the Internet Engineering Task Force (IETF) works specifically on developing IP routing protocols topologies. To improve mobile routing and interface definition standards for use within the Internet protocol suite [2].

In spite of extensive research work on MANET, it does not have a complete form of Internet based standards till recently. In 2003 drafts for the routing protocols were proposed by IETF working group and are referred as Request for Comments (RFCs) [1]. In these RFCs the questions related to implementation or deployment of the routing protocols are unanswered. But these proposed algorithms are identified as a trial technology and there are high chances that they will be developed into a standard [1]. Extensive research work in this area is in progress with studies on different routing protocols such as Ad-hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR), Temporarily Ordered Routing Algorithm (TORA) and Optimized Link State Routing (OLSR) [1].

Routing is the process of selecting paths in a network along which to send network traffic. The basic groups of routing protocols in MANETs are Proactive routing protocol, Reactive routing protocol and Hybrid Protocol. The Proactive routing protocol is generally called table driven protocol and it detects the network layout periodically. Reactive routing protocol is called on-demand routing protocol and finds the route when a source node requests to communicate with the other. On-demand approach is suitable for the nodes with high mobility and nodes that transmit data rarely. The main drawback of reactive routing protocols is that the source node broadcasts the routing requests in the whole network and it waits for the responses. This route discovery procedure causes significant delay and makes them less suitable for real time traffic [3]. Hybrid routing protocol integrates the merits of Proactive and Reactive Protocols.

The performance evaluation of reactive protocol (AODV) and improved AODV will be carried out with respect to parameters such as Average End-to- End delay, Average Jitter, Total bytes received, Total packets received and Throughput using Qualnet 5.0.2 network simulator.

II. Literature Survey

Extensive research work has been done in the field of MANET routing protocols. Some of the related works are discussed here. In document "Ad hoc On-Demand Distance Vector (AODV) Routing" [1] authors have come out with RFC 3561 which explains AODV Routing protocol.

In the paper "Performance Comparison of Ad-Hoc Wireless Network Routing Protocols*"* [4] four different routing protocols like AODV, TORA, DSDV and DSR are compared. It is shown through simulation results that DSR generates less routing load than AODV.

Performance comparison of AODV and DSR routing protocols in a constrained situation is done using GloMoSim by authors in the paper "Performance Comparison of AODV/DSR On-Demand Routing Protocols for Ad Hoc Networks in Constrained Situation" [5].

A comparison of Link State, AODV and DSR protocols for two different traffic classes, in a selected environment is done in "Performance Comparison of Routing Protocols for Ad hoc Networks" [6].

In ''Evaluation of Ad Hoc Routing Protocols in Real Simulation Environments'', [7] the authors give different kind of conclusions about the MANET routing protocols i.e. DSDV, AODV and DSR these are simulated in NS2.

"Performance comparison of Two On-Demand Routing protocols for Ad hoc Networks" from Perkins et. all [8] show the performance of two On demand routing protocols namely DSR and AODV.

In the paper "ZRP versus AODV and DSR: A comprehensive study on ZRP performance" [9] authors compared three routing protocols AODV, DSR and ZRP using Qualnet 4.5 simulator.

III. REACTIVE ROUTING PROTOCOLS

Reactive protocol is identified as On-demand protocols because it creates routes only when these routes are needed. The need is initiated by the source, as the name suggests. When a source node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible route permutations have been examined. After that there is a route maintenance procedure to keep up the valid routes and to remove the invalid routes. The Ad-hoc on demand distance vector reactive routing protocol is discussed below.

A. Ad-hoc On-Demand Distance Vector Routing (AODV)

Ad-hoc On-Demand Distance Vector (AODV) routing is a routing protocol for mobile ad-hoc networks and other wireless ad-hoc networks. It is jointly developed by C. Perkins and S. Das. It is an on-demand and distance-vector routing protocol, meaning that a route is established by AODV from a destination only on demand [10]. AODV defines three types of control messages for route maintenance as shown in fig.1.

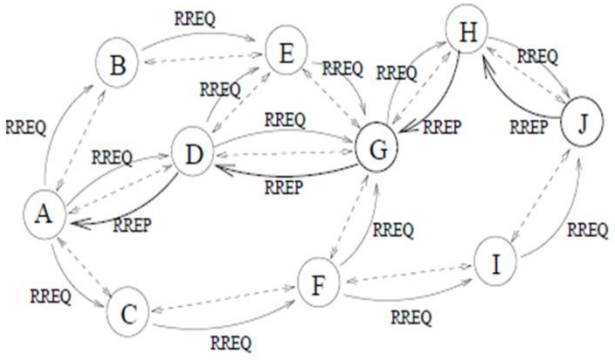

Figure 1: Route maintenance in AODV

- *RREQ*- A route request message is transmitted by a node requiring a route to a node. As an optimization AODV uses an expanding ring technique when flooding these messages. Every RREQ carries a time to live (TTL) value that states for how many hops this message should be forwarded.
- *RREP*- A route reply message is unicasted back to the originator of a RREQ if the receiver is either the node using the requested address, or it has a valid route to the requested address.
- *RERR*- Nodes monitor the link status of next hops in active routes. When a link breakage in an active route is detected, a RERR message is used to notify other nodes of the loss of the link. In order to enable this reporting mechanism, each node keeps a "precursor list", containing the IP address for each its neighbours that are likely to use it as a next hop towards each destination.

B. Improvement in AODV routing protocol.

AODV routing protocol is dynamic in nature, hence whenever a new route is to be found, RREQ messages are broadcasted into the network. After finding a route to destination, RREP message is unicasted from destination to source. In this time window there is loss of packets in the network, hence an improvement is proposed and is called Improved AODV (I-AODV) routing protocol, in which hello messages are used for verifying the active nodes in the network. In standard AODV protocol the hello messages are generated randomly. However in I-AODV hello messages are generated for the entire time of the simulation. All the nodes in the network know whereabouts of their neighbouring nodes as compared to AODV routing protocol, which results in increased speed of operation for I-AODV.

IV. SIMULATION AND RESULTS

In this work QualNet 5.0.2 simulator with wireless module is used for simulation to enable mobility of the wireless nodes and support more accurate wireless models for propagation, path loss, multipath fading and reception on wireless networks. The simulations are carried out for network sizes of 10, 20, 30, 40, 50 and 60 nodes with simulation area 500m X 500m, simulation time of 300 second and random node placement method. The fig. 2 shows a snapshot of Qualnet network simulator for 20 nodes MANET scenario, CBR traffic is selected as the application.

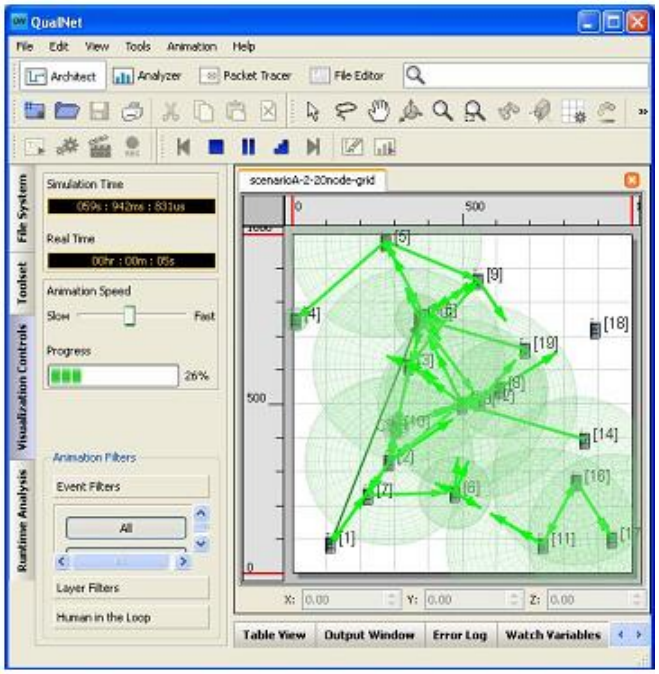

Figure 2: Snapshot of Qualnet 5.0.2 simulator.

a) Total Bytes Received: Total bytes received for AODV and Improved AODV protocols under various node density scenarios are shown in fig.3. It can be observed that total bytes received for Improved AODV is more than AODV, due to enhance mechanism of better route search. The decrease in received bytes for the AODV protocol with increase in node density is observed, which is due to increase in number of hops which in turn increases the routing over head for route discovery. This ultimately results in dropping of packets for standard AODV.

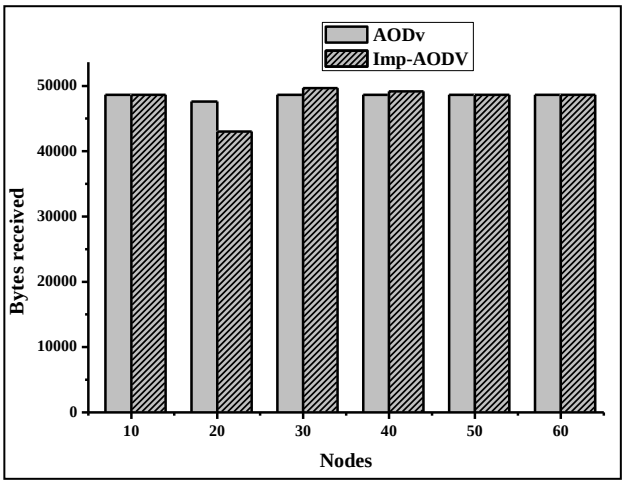

Figure 3: Total bytes received for AODV and Improved AODV protocols

b) Packet Delivery Ratio: The variation of packet delivery ratio for different node density is shown in Fig.4. It is clear from the fig 4 that performance of improved AODV is better for low node density (10-40 nodes) as compared to AODV. However, for 50 and 60 nodes the performance is the same as the standard AODV. This is due to better routing mechanism in Improved AODV as compared to AODV.

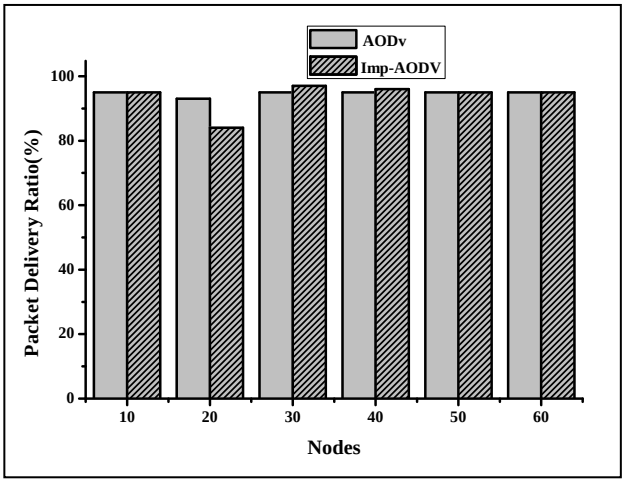

Figure 4: Packet delivery ratio for AODV and Improved AODV protocols

c) Throughput: Fig 5. Shows the throughput values for AODV and Improved AODV protocols for various node densities. It is observed that the throughput for improved AODV is better as compared to AODV as there is very less time required to establish a better route to the destination.

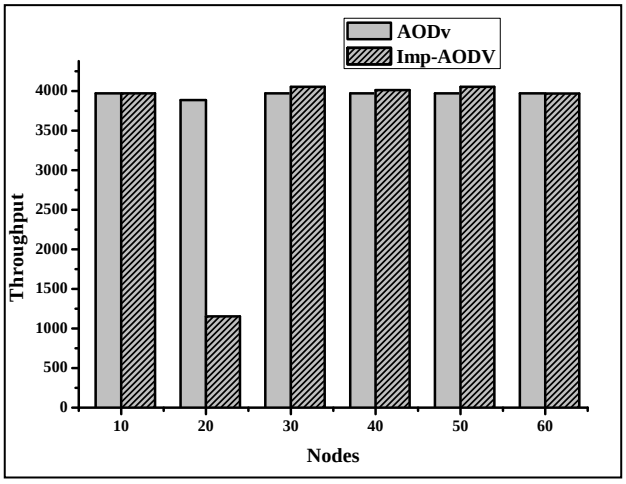

Figure 5: Throughput for AODV and Improved AODV protocols

d) Average end-to-end delay (seconds): The variation of End-to-End Delay with variation in node density is shown in fig. 6. From fig 6, it can be observed that End-to-End delay for AODV is smaller as compared to Improved AODV. When the node density is increasing, the end to end delay for Improved AODV protocol increases drastically as there is generation of hello messages throughout the simulation time.

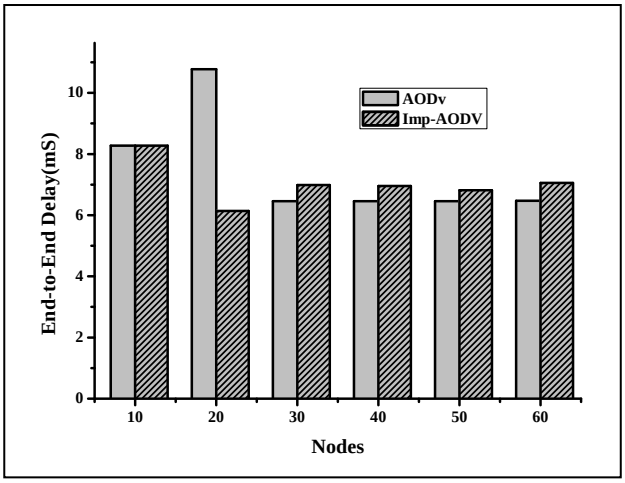

Figure 6: End to End delay (ms) for AODV and Improved AODV protocols

e) **Average Jitter:** The average jitter for AODV and Improved AODV protocols as the node density increases is shown in Fig.7. Due to minimum number of control messages in AODV, jitter is considerably less. When the

node density increases Improved AODV shows better performance as compared with AODV.

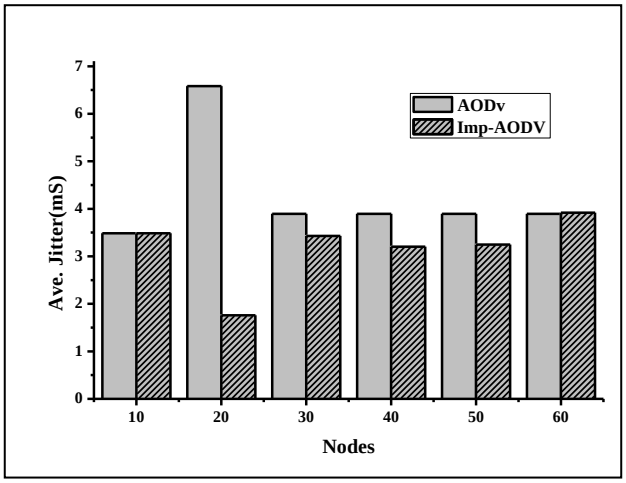

Figure 7: Average jitter (ms) for AODV and Improved AODV protocols

V. CONCLUSION

The simulation study consists of routing protocols AODV and Improved-AODV deployed over MANET for various node densities. The metrics used for the performance study include average end-to-end delay, total bytes received, packet delivery ratio, throughput and average jitter. The results showed that I-AODV performed better in parameters such as total bytes received, packet delivery ratio and throughput due to their better route discovery with minimal time. I-AODV shows poor performance in delay and jitter parameters. Hence I-AODV is suited for applications were packets transmission is crucial.

ACKNOWLEDGEMENT

The authors would like to thank UGC for sanctioning the funds under major research project. One of the author M. Subramanya Bhat, also thank the management of BHS higher Education Society, Bangalore and UGC for providing him the opportunity avail FIP. Authors would also thank Nihon communication, Bangalore for their support.

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