

April 2015

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Recommended Citation

JAIN, MANJHARI; WAOO, AKHILESH; and Patheja, P. S. (2015) "SIMULATION AND PERFORMANCE ANALYSIS EVALUATION FOR MULTIPATH EXTENSION OF AODV TO IMPROVE END TO END DELAY, ROUTE ERROR SENT, ROUTING LOAD AND PACKET DROP RATIO," *International Journal of Computer and Communication Technology*. Vol. 6 : Iss. 2 , Article 4.

Available at: <https://www.interscience.in/ijcct/vol6/iss2/4>

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SIMULATION AND PERFORMANCE ANALYSIS EVALUATION FOR MULTIPATH EXTENSION OF AODV TO IMPROVE END TO END DELAY, ROUTE ERROR SENT, ROUTING LOAD AND PACKET DROP RATIO

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Abstract—This paper describes improvement in standard routing protocol AODV for mobile ad-hoc networks. Our mechanism setups multiple optimal paths based on bandwidth and delay. It allows to store multiple optimal paths based on Bandwidth and delay. At time of link failure, it will switch to next available path. To set up multiple paths, we have used the information that we get in the RREQ packet and also send RREP packet to more than one path. It reduces overhead of local route discovery at the time of link failure and because of this End to End Delay and Drop Ratio decreases. The main feature of our mechanism is that it is simple, efficient. We evaluate through simulations the performance of the AODV routing protocol including our scheme and we compare it with HLSMPRA (hot link split multi-path routing algorithm) Algorithm. Indeed, our scheme reduces routing load, End to End Delay, route error sent, and Packet drop ratio. The simulations have been performed using network simulator OPNET-14.0. The network simulator OPNET is discrete event simulation software for network simulations which means it simulates events such as sending, receiving, forwarding and dropping packets.

Keywords: AODV, Bandwidth, End to End Delay, Optimal path, Opnet, Packet Drop, Routing Load, Route Error sent.

1. INTRODUCTION

Ad hoc networks are presently enjoying unprecedented research interest, and are expected to provide opportunities for utilization of network applications in new scenarios in which today Internet-based communication paradigms are no longer applicable. In particular, we expect that ad hoc networks will be formed in situations where no infrastructure is available, and for which no predetermined subnet structure is known. Ad hoc networks are typically considered to be composed of mobile wireless devices, with the result that the interconnection pathways between the devices can change rapidly. This characteristic often causes ad hoc networks to be viewed more quite different than traditional networks; however, our experience shows that instead there is a strong commonality which, as we learn to understand it better, will illuminate not only the nature of ad hoc networks but also some fundamental aspects of networking [1].

In a network composed of mobile nodes, changes in the network topology required the frequent rebuilding of routes, so maintaining stable routes may be infeasible. Therefore, MANET is a communication network of a set of mobile nodes, placed together in an ad hoc manner, without any fixed infrastructure that communicate with one another via wireless links. All nodes have routing capabilities and forward data packets for other nodes in multi-hop fashion. Nodes can enter or leave the network at any time, and may be mobile, so that the network topology continuously

changes during deployment. The need for exchange of digital information outside the typical wired office or unarranged environment is growing such as a class of students may need to interact during a lecture; business associates serendipitously meeting in an airport may wish to share files; or disaster recovery personnel may need to coordinate relief information after a hurricane or flood. Each of the devices used by these information producers and consumers can be considered a node in a MANET [2].

2. ROUTING IN MANET

“Routing is the process of information exchange from one host to the other host in a network.”. Routing is the mechanism of forwarding packet towards its destination using most efficient path. Efficiency of the path is measured in various metrics like, Number of hops, traffic, security, etc. In Ad-hoc network each host node acts as specialized router itself [4].

2.1 Different Strategies

Routing protocol for ad-hoc network can be categorized in three strategies.

- a) Flat Vs Hierarchical architecture.
- b) Pro- active Vs Re- active routing protocol.
- c) Hybrid protocols.

2.2 Flat Vs. Hierarchical architecture

Hierarchical network architecture topology consists of multiple layers where top layers are more seen as master of their lower layer nodes. There are cluster of nodes and one gateway node among all clusters has a duty to communicate with the gateway node in other cluster. In this schema there is a clear distribution of task. Burden of storage of network topology is on

gateway nodes, where communicating different control message is dependent on cluster nodes.

But this architecture breaks down when there is single node failure (Gateway node). Gateway nodes become very critical for successful operation of network. Examples include Zone-based Hierarchical Link State (ZHLS) routing protocol. Where in flat architecture there is no layering of responsibility.

2.3 Proactive Vs Reactive routing protocol in MANET

2.3.1 Proactive routing protocol

In this, each node maintains the network topology information in the form of routing tables by periodically exchanging routing information. Routing information is generally flooded in the whole network. Whenever a node needs a route to the destination it runs an appropriate path finding algorithm on the topology information it maintains [4].

Current routing protocol like Link State Routing (LSR) protocol (open shortest path first) and the Distance Vector Routing Protocol (Bellman-Ford algorithm) are not suitable to be used in mobile environment. Destination Sequenced Distance Vector Routing protocol (DSDV) and Wireless routing protocols were proposed to eliminate counting to infinity and looping problems of the distributed Bellman-Ford Algorithm[5].

Examples of Proactive Routing Protocols are:

- a) Global State Routing (GSR).
- b) Hierarchical State Routing (HSR).
- c) Destination Sequenced Distance Vector Routing (DSDV).

2.3.2 Reactive routing protocol

In this type of routing protocol, each node in a network discovers or maintains a route based on-demand. It floods a control message by global broadcast during discovering a route and when route is discovered then bandwidth is used for data transmission. The main advantage is that this protocol needs less routing information but the disadvantages are that it produces huge control packets due to route discovery during topology changes which occurs frequently in MANETs and it incurs higher latency. [4]

Examples of reactive protocols are:

- a) Ad hoc On-demand Distance Vector Routing (AODV).
- b) Dynamic Source Routing (DSR).
- c) Location Aided Routing (LAR).

d) Temporally Ordered Routing Algorithm (TORA).[5]

2.4 Hybrid routing protocols in MANET

These protocols combine the best features of the above two categories. Nodes with a certain distance from the source node concerned or within a particular geographical region are said to be within the routing zone of the given node. For routing within this zone, a table-driven approach is used. For nodes located beyond this zone, an on-demand approach is used. [4]

2.5 Cost benefits trade-off between proactive and reactive protocols

Advantage: proactive Vs reactive

Proactive protocols: Routes are readily available when there is any requirement to send packet to any other mobile node in the network. Quick response to Application program.

3. AD HOC ON DEMAND DISTANCE VECTOR (AODV)

The information in this section concerning the Ad Hoc on Demand Distance Vector Protocol (AODV) protocol is taken from the RFC [6]. AODV is a reactive protocol, i.e., so the routes are created and maintained only when they are needed. The routing table stores the information about the next hop to the destination and a sequence number which is received from the destination and indicating the freshness of the received information. Also the information about the active neighbors is received throughout the discovery of the destination host. AODV provides on-demand route discovery in MANET [7]. Whenever the nodes need to send data to the destination, if the source node doesn't have routing information in its table, route discovery process begins to find the routes from source to destination. Route discovery begins with broadcasting a route request (RREQ) packet by the source node to its neighbors. RREQ packet comprises broadcast ID, two sequence numbers, and the addresses of source and destination and hop count. The intermediary nodes which receive the RREQ packet could do two steps: If it isn't the destination node then it'll rebroadcast the RREQ packet to its neighbors. Otherwise it'll be the destination node and then it will send a unicast replay message, route replay (RREP), directly to the source from which it was received the RREQ packet. A copied RREQ will be ignored.

The advantages of AODV are that less memory space is required as information of only active routes are maintained, in turn increasing the performance, while the disadvantage is that this protocol is not scalable and in large networks it does not perform well and does not support asymmetric links.

4. HLSMPRA Algorithm

HLSMPRA algorithm mainly aims at dealing with the degradation of performance in whole networks resulting from rare area congestion in wire transmission network. Firstly, the focus of our work is to keep the routing information in the source node, so as to conduct data transmission in method of alternative path or multi-path intercurrently in source node when congestion happens. Secondly, check congestion regularly, meanwhile record the bandwidth of each link, and then judge whether the link in the state of overload by comparing excess bandwidth.

4.1 HLSMPRA Algorithm Procedures:

- (1) Call Dijkstra algorithm, evaluate the shortest path **sp** between source node and destination node, if set **SP** is null set, quit, and otherwise continues.
- (2) Search and compare each path in **SP**, and do statistics of each link frequency. Range them in order from high to low.
- (3) Check the excess bandwidth of each link in **SP** regularly.
- (4) We can judge from the result which link is heavy load link, and put it into set **A**; that it's a idle link, put the links which satisfies the condition into set **B**.
- (5) Pick up links from the set **A**, if $k=0$ stop and otherwise to continue procedure 6.
- (6) Find out the upstream node **w** of the heavy link, find out **w** node in idle set, and select the node link of next hop. Get data packet through the path, make the bigger Bandwidth path of surplus link as the first priority links.
- (7) After selecting the new path, figure out the surplus bandwidth, and then sort it out and put into corresponding set (set **A** or set **B**)
- (8) If $k=0$ stop calling the algorithm; otherwise, to continue to check the heavy load links, and split stream, then jump into the step 4.

5. Proposed System

In the proposed algorithm, multipath is discovered and maintained in advance at the time of route discovery, but instead of considering each and every RREQ at each node it will consider only specified number of request. At destination or intermediate node, RREP is sent to every received RREQ from unique node. Thus more than one path is maintained

all with same but optimal paths will be stored in routing table and one of them will be used for data transfer. Other non used optimal paths will be used at time of link breakage.

It has three phases, Route Discovery, Data Sending and Route Maintenance

5.1 Route Discovery

Route discovery is initiated by the source node when it has some data to send and does not have the route table entry for the destination. It broadcasts RREQ packet to its neighbors.

When Intermediate node gets RREQ, it will check for the route table entry, for the destination mentioned in the RREQ packet. If it finds route table entry for the destination, it will generate RREP packet and send it to the source. If it doesn't have the route table entry for that destination it will rebroadcast the RREQ, after updating the route entry for the source.

When RREQ packets come at the destination, it will generate RREP packet for each RREQ packet, and unicast it to the source.

5.2 Data Sending

Data will be sent as soon as the first RREP packet comes to the source data packets will be sent and it will traverse hop by hop.

5.3 Route Maintenance

If a link break is detected, it will check for the unreachable destination and if any, it will broadcast a Route Error (RERR) packet. The entire node getting RERR packet, will re broadcast it if and only if there is at least one unreachable destination.

As we have alternate optimal paths, when a data packet arrives, it will use the next path which is available. i.e. It switch to the next optimal path on route failure and will send the RERR only when it does not have any alternate path for the destination.

5.4 Proposed Algorithm Procedures:

This Algorithm performs following steps:-

- 1) Estimate the Delay, Bandwidth, availability, mobility of each node.
- 2) Calculate the validity of each route for available packet forwarding/transmitting for selecting optimal path.
- 3) Remove the available routes, which is not satisfied the above condition.
- 4) Randomly select any one route from the available routes, which provides optimal route.
- 5) Sends the packet using optimal route.

6. SIMULATION ENVIRONMENT

6.1 Simulation Model

Here we give the emphasis for the evaluation of performance of Ad Hoc routing protocol AODV with varying the number of mobile nodes. The simulations have been performed using network simulator OPNET. The network simulator OPNET is discrete event simulation software for network simulations which means it simulates events such as sending, receiving, forwarding and dropping packets. The version of OPNET is 14.0, supports simulation for routing protocols for ad hoc wireless networks such as AODV, TORA, DSDV, and DSR. OPNET is written in C++ programming language and Object Tool Common Language (OTCL). Opnet allows you to model network topologies with nested sub-networking approach. This software allows nodes and protocols to be modeled as classes with all features of object oriented design It facilitates modeling the behavior of individual objects at the "Process Level" and interconnect them to form devices at the "Node Level" So that you can interconnect devices using links to form networks at the "Network Level." You can organize multiple network scenarios into "Projects" to compare designs and Aggregate traffic from LANs or "Cloud" nodes [8].

The OPNET model in its very core consists of C++ codes. These codes are compiled and executed just like the C++ program. This enables very detailed control of the model by the user (if the user is proficient in C++).

6.2 Simulation Parameters

We consider a network of nodes placing within a 1000m X 1000m area. The performance of AODV is evaluated by keeping the network speed and pause time constant and varying the network size (number of mobile nodes).Table 1 shows the simulation parameters used in this evaluation.

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Simulation Parameter	
Simulator	Opnet-14.0
Protocol	AODV
Simulation Duration	30 min
Number of nodes	13
Pause Time	100sec
Average Speed	102.714 events/sec
Addressing Mode	IPv4
Packet Size(bits)	1024
Data Rate(bps)	11mbps
Buffer Size(bits)	256000

Table: 1

6.4 Performance Metrics

While analyzed the AODV protocol, we focused on three

Performance metrics which are End to End Delay, Routing Load, Total route error sent.

The graphs Figure 1 to 4 shows that the overall performance- End to End Delay, normalized routing load, Packet Drop and Total route error sent are improved by using our local route repair method.

End-to-End Delay: A specific packet is transmitting from source to destination and calculates the difference between send times and received times. Delays due to route discovery, queuing, propagation and transfer time are included in the delay metric.

Routing Load: 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.

Total Packet Drop: Due some error in transmission, there may be a chance of packet loss in wireless communication. Packet losses may occur because of the mobility of the nodes. Mobility also induces route change in the network which is tolerable but packet loss is not tolerable for effective communication in wireless network.

Total Route error sent: In routing protocols the nodes generates error packets when the route is interrupted or broken. These packets are diffused to nearby nodes which are affected due to route break. The total number of routing packets transmitted during the simulation.

5. SIMULATION RESULTS & OBESRVATION

In this paper, local retransmission is used to improve the End to End Delay. Improved Delay, Routing Load denotes the efficiency, reliability and effectiveness of proposed routing protocol. Thus, the total route error is reduced to some extent. Though it is expected to produce minimum error sent for the proposed routing Algorithm; Total Delay is an indication of reliability, efficiency, and effectiveness of routing protocol. From Figure 1, the Total Delay shows improved reliability, effectiveness and efficiency, figure 2 shows Routing Load, figure 3 shows total packet Drop and figure 4 shows total route error sent.

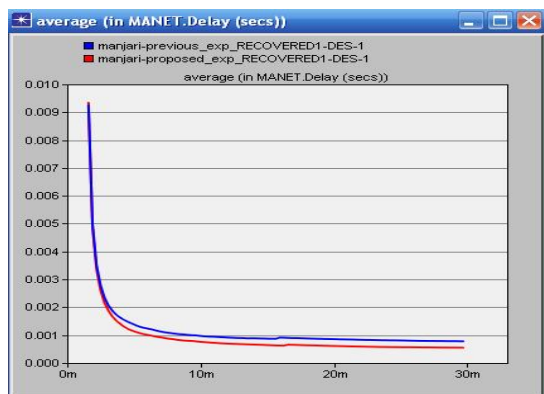


Figure 1: Total Delay

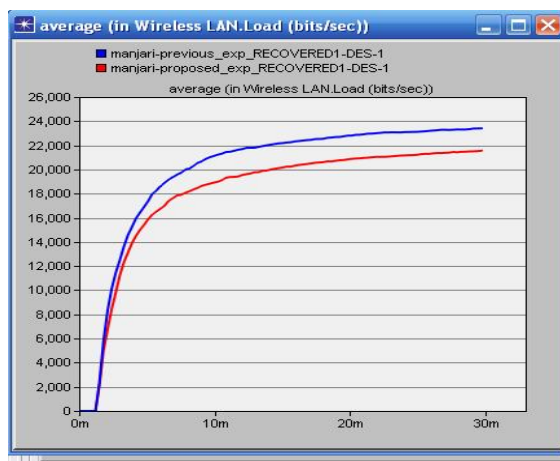


Figure 2: Routing Load

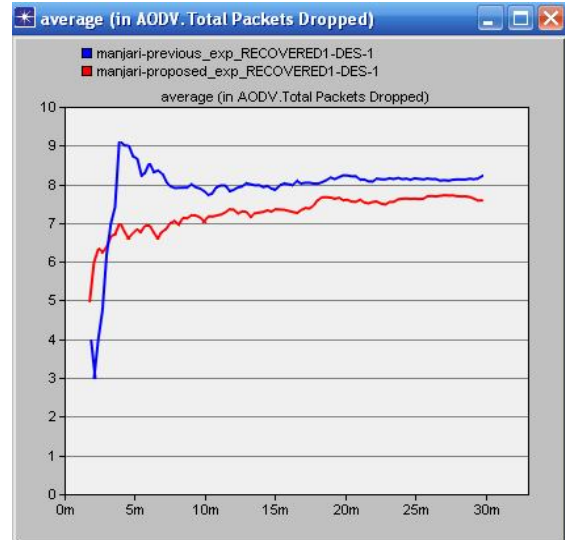


Figure 3: Total Packet Drop

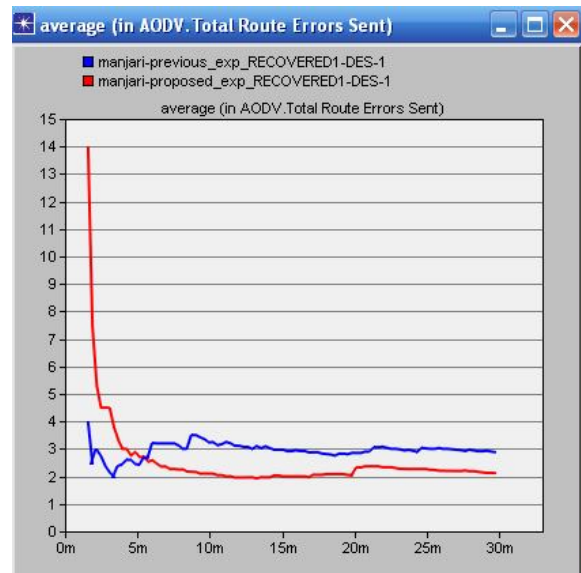


Figure 4: Total route error sent

CONCLUSION

The proposed algorithm will generate slightly higher overhead than that of Previous Algorithm for first time at the time of route discovery. But once route discovery is over, it will be beneficial for route maintenance. And this overhead overcomes the route overhead generated at the time of link failure. The proposed Algorithm reduces the total Delay, Routing Load, Packet Drop, Total route error sent. This algorithm is based on Optimization. The proposed algorithm improves the efficiency, robustness and reliability. The efficiency of proposed Algorithm shown to better than Previous Algorithm.

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