A Design and Analysis of EOM for Energy Saving and Effective Routing Protocol: AODV and AOMDV

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Abstract

Objective: The main objective of the work is to enhance the routing performance of the network by increasing the quality of service parameters. Increasing the routing performance will lead to increase in the network performance and the efficiency of the existing network. So an algorithm is designed which lead to the higher performance of the network.

Method Analysis: In this an algorithm is proposed which is designed on the basis of the residual power of the nodes and the other resources available to the nodes. Using the residual power and other resources information the nodes tries to manage the packet loss in the network by routing the packet through another available path in the network. Findings: The proposed algorithm is implemented using the AODV and AOMDV routing protocol. The AODV and AOMDV routing protocols are analyzed on the basis of various performance metrics and the problem of route failure which leads to packet loss in the network and the increase in the overheads in the network is demolished to some extent. This will lead to better performance of the network and more reliable communication in the environment. There is an incredible increase in the performance metrics of the network which will ultimately leads to network with higher efficiency rate. Improvement: The proposed methodology is an advance version of the previous existing work and there by providing with better results and network scenario which will have higher quality of service parameters.

Keywords: AOMDV (Ad-hoc on demand multipath distance vector routing protocol), AODV (Ad-hoc on demand distance vector), EOM (efficient optimization module), Path Recovery, Residual Power

1. Introduction

1.1 MANET Architecture

In mobile ad-hoc network there is no central controller. Each node in the network act as both router and the destination. These networks are therefore are also called as the decentralized networks in which there is no fixed topology. The mobile nodes are such flexible that they can configure themselves with random topology. In this type of topology the nodes are attentive about their neighboring nodes and also knows which nodes is in direct communication range with them. When the two nodes directly communicate with each other then it is known as single-hop communication. When the two nodes are not in range with each other they, then they try to communicate each other through intermediate nodes then it is known as multi-hop communication.

Figure 1 illustrates the mobile ad-hoc networks in which the networks consists of mobile devices like laptops and mobile phones. Each mobile devices is configured to form a network. In MANET each node or device is unified to each other by multi-hop communication. In the network every node is that much active, that is always in ready state so that it can transmit or receive the data packets whenever it with that particular node. For the transmission of packets in routing of the packets the network used certain routing protocol so that packet can efficiently reach the destination without the loss in the network. The nodes in the network can be deployed in either fixed or mobile manner. The nodes are connected to each other by the wireless media and therefore no physical medium exists between two mobile devices.
1.2 Characteristics of MANET

MANET have the characteristics of the wireless network. The additional other characteristics of the ad-hoc networking are as discussed below:

- **Based on Ad-hoc**: An ad-hoc network is the impermanent network which is formed dynamically in a random manner by the collection of various number of nodes as per the requirement of the network.

- **Wireless**: Nodes in the network communicate with each other wirelessly that is they do not require any wired or physical medium to get connected with each other. The medium through which they get involved in communications are by using radio transmission range, infrared waves, microwaves etc.

- **Autonomous**: MANET is ad-hoc network in which there is no fixed network means it can be called as infrastructure less networks. Also there is no central administration. In each node is randomly deployed also each node operates in distributed peer to peer mode. Each node in the network can act as both the independent router as well as independent destination.

- **Mobility**: Nodes in the mobile ad-hoc network has liability to move anywhere and anytime in the network while in communication with another neighboring nodes. Due to random movement of node participating in the communication the network topology keeps on changing randomly continuously. As the consequence of which there may me interruption in the communication.

- **Multi-hop routing**: In the network it is not necessary that each should be dedicatedly link to each other for getting into the communication. The nodes which are far away from each other or not in direct communication range they can be get into dialogue through the intermediate nodes. Each intermediate nodes can act as router and therefore can forwards the data packets so that nodes can share the information.

1.3 Routing Protocols

In MANET the routing protocols are mainly classified on the basis of update mechanism of the routing information. In this type of class the routing protocol used all the routing information for the delivery of packets. The use of network information is used to route the data packets. The routing protocols make use of many efficient algorithm for the selection of routing path. On periodic basis the routing information keeps on updated so that stale information can't be the source of error. So the table keeps on updated as per the need. In this type there are three classes of routing protocols and also they play important role in the mobile ad-hoc network. The three classes of routing protocols are:

- Proactive routing protocol
- Reactive routing protocol
- Hybrid routing protocol

For the study we are considering the AODV and AOMDV routing protocols which falls under the category of the reactive routing protocols. These routing protocols use the Dijkstra algorithm for finding of the shortest path in the network.

1.3.1 Dijkstra Algorithm

This is the algorithm which is used for finding the shortest path in the weighted graph. In this the nodes are divided into groups, one is the tentative and other one is permanent. The algorithm is designed in such a way that the current node finds all its neighbor and designed them as the tentative, then the examination for all the tentative nodes is done if the nodes passes all the criteria then they are moved into permanent list. The criteria is that the next node to be in tentative list must have minimum link cost or the weight should be minimum. The basic flow for this algorithm is designed in Figure 2. Firstly the root of the tree is decided and then corresponding node is move to the tentative list. So initially the permanent list is empty and the tentative is occupied by the one node for which local root has to be find. Then all the neighbors of the nodes that is placed in the tentative list are found and after that the cumulative cost of the edges are analyzed and the node firstly placed in the tentative list is now move to the permanent list. After that all the neighbors that are found are placed in the tentative list, then among the neighbors which has the shortest aggregate cost is placed into the permanent list. So the process keeps on repeating itself
till the tentative list became empty. The calculation of shortest path is quite fast as compared to other shortest path finding algorithm. In many wireless routing protocol this algorithm is used to find the shortest path so that efficient routing can be achieved in the network.

![Flow diagram of Dijkstra algorithm](image)

**Figure 2.** Flow diagram of Dijkstra algorithm.

### 1.3.2 Ad-hoc on Demand Multipath Distance Vector (AOMDV) Routing Protocol

AOMDV is a multi-path routing protocol that belongs to the class of reactive protocols. It has edge over other existing protocols as it has less routing load and least delay. AOMDV is developed to debar link failures and path breaks. The route initiation process is same as that of AODV byflooding of RREQ packets in to the network. Once the RREQ is received by the network the intermediary nodes keep the track of the former hops and checks for freshness and coherence of the destination. The RREP is sent by the node with a different sequence number to the source. The route recovery process comprises of two cases: first is the link disjoint that is whenever the link is out of order. This link disjoint occurs to the topology change in the network. When there is a link failure the RERR packet is sent in order to notify the source about it. Second, AOMDV makes the use of soft state routing in order to keep its routing table periodically updated in case of the path is terminated. In order to validate the route each node sends a beacon signal periodically.

In’ have given new idea about the nodes in the network. They described that in addition of function of nodes of forwarding the data packets, the random nodes in the network are also responsible for other computational tasks. The difference in processing time, energy consumption and also the load imbalance among the nodes are few issues that need to be consider. Therefore there must be sharing of loads between the idle nodes and the node which is overloaded. Thus to resolve this issue new algorithm has been proposed related to load balancing which basically is based on clustering. In this the network is divided into different groups in the form of cluster, and each subset has cluster head. The responsibility of cluster head is to maintain the balance among the cluster nodes in addition to this the communication cost should also be minimized. Reduction in total execution time by dividing the processes among the nodes is the main motive of this algorithm. In addition to this to increase the stability, lifetime of the node having load is another purpose. The experimental results shows that the network performance of the overloaded nodes approaches to the network performance of the idle node.

In’ discussion about that route failure which are caused due to mobile nature of the node or due to power constraint in the network are not detected by the congestion is there. In this two phase technique has been proposed to address the link failure through the congestion control. The algorithm is based on end to end threshold which supports the enhancement of congestion control so that it can address the link failure prior to it happens. They carried out this congestion in the transport layer of the model.

In’ the authors has discussed about the various issues or challenges in the mobile ad-hoc network. So to overcome those challenges many routing protocol has been studied and compared and as the result most efficient routing protocol is provided. The main focus is on the problem namely congestion control. Due to congestion there is the delay in the communication and also the decrease in the network performance. So to overcome this congestion they suggested to follow multipath routing scheme for the better outputs and communication. So multipath routing protocol is one of the main solution for the congestion control.

In’ an algorithm is proposed for the reduction of the overhead in the mobile ad-hoc network which occurs due
to the link failure. The nodes in the network have limited power so there is huge probability of collapsing the node while it is active participant in the communication. So there may be chances of the route failure or interruption in the ongoing communication which leads to the great overhead in the network and also the loss in the packets. So to reduce this an algorithm has been designed which is based on life time of the network and the computational prediction of the lifetime of the network which helps in dealing with the situation described above. In this each node measures its battery lifetime and remaining energy and also its previous resources. The proposed algorithm is implemented with the AODV routing protocol and then compared with original AODV and concluded that AODV with proposed algorithm has better quality of service parameters.

In	extsuperscript{9} they have considered the congestion as the major problem in the mobile ad-hoc network and also taken into account its major effects on the parameters like throughput, routing and network performance. Finding the causes of congestion is the tedious and difficult task in the mobile network. So to remove this threat new approach has been followed to overcome the congestion challenge. In paper proposal of congestion control over the link-layer has been design for the wireless mobile ad-hoc network. In this the delay and bandwidth is measured at each node alongside of the path. From these obtained value the receiver nodes calculates the size of the new window and accordingly send the packet through that window to the sender and sender take it as the feedback from the receiver. The nature of the sender has been increased significantly and also the proposed technique is also compatible with existing standard TCP.

In	extsuperscript{8} the simulation is formed for the AODV and AOMDV routing protocol. AODV is the single path routing protocol whereas the AOMDV is the multipath routing path. For both the routing protocol the simulation parameters like throughput, node lifetime, jitter, energy consumption, end to end delay and various other parameters are considered for the comparison of both the protocol and then evaluation of the routing protocol is carried out.

In	extsuperscript{7} a new algorithm has been proposed for curing the route failure problem in the network. Nodes are mobile in the network so they keep on moving in random fashion in the network which leads to the reduction in node power. So as the result there may chances of route failure. So to overcome this challenge a new algorithm has been proposed which cure the link failure up to some extent. The new algorithm proposed to measure the strength of the received signal and also the power status of the battery in the network. With the help of these two measured value a situation is assumed where the link is about to fail and to avoid that failure the source node spread the route request packet for the selection of new route in the network for the successful delivery of the data packets. In this route maintenance, link failure prediction and route recovery is performed. By the simulation it is clear that the proposed algorithm reduce the energy consumption and the life time of the network increases with the better performance metrics.

In	extsuperscript{6} they suggested that some of the routing protocols transfer the packet in very effective and efficient way. They proposed a dynamic queue which is energy efficient and uses the concept of load balancing. The packet loss decreases by using the multipath ad-hoc protocol along with the evenly distributed traffic. They proposed a technique in which by not even using the energy factor the proposed mechanism is better in partial life time. Other performance parameters are also compared and concluded that the proposed technique is better than the existing one.

In	extsuperscript{5} explanation about the link failure is there. Due to the mobility characteristics of the nodes in the network, the node may enter or exit the network according to their wish. As absence of central administration no control over any node. So due to these reasons there are chances that the active communication may get destroyed due to movement of the node, path breakage may arise in this condition. So loss in the quality of service parameters and increase in packet loss situation may arises. So to avoid this situation algorithm for curing of the link failure has been designed. The algorithm are based on quantum approach. It will be performed in the section wise. Firstly route discovery is performed then followed by link failure detection algorithm and finally local link failure recovery algorithm is performed. They include the counting of number of hops	extsuperscript{10} existing in the path and there by design the routing protocol based on quantum approach and analyze the performance metrics with normal existing routing protocol and the protocol having quantum based approach.
1.3.3 Scope of the Work

In MANET, the dynamic nature of the node and absence of the centralized administration always been an issue which degrades the performance of the network. For the transmission of data packets many routings protocols are proposed. Besides having so many routing protocol challenges while routing the packets still persists. While routing there is probability that the node may displace from its initial position this may cause due to the reason that the node may move out of the power or due its mobile nature. So if this situation arises the ongoing communication gets affected. There may be the breakage in the path. Due to failure in the link, packet loss occurs and thereby increase in the overheads in the network. So as the result the network performance degrades. So an algorithm is proposed that will prevent this issue and hence increase in the network performance. The algorithm designed will be an efficient optimization module (EOM). The parameters like throughput, energy, end to end delay and packet loss are taken into account for the comparison of routing performance for the different routing protocols. So overall scope of the work is to enhance the routing performance of the routing protocol by increasing the quality of service parameters.

2. Proposed Algorithm

The characteristic of self-configuring in mobile ad-hoc network allows the mobile nodes in the network to exist or join the network whenever they wants to. The network is deployed with the nodes and the path is established between the source node and the destination node. The path establishment is done according to the AODV and also by AOMDV routing protocol. In the scenario there may presence of nodes which are having mobility greater than the other nodes. So due to difference in the mobility there may probability of link failure. Due the failure in the link there is degradation in the routing performance which leads to the degradation in the network performance. To overcome this problem of link failure a novel technique is proposed known as the Efficient Optimization Module (EOM). The proposed EOM module enhance the routing performance in the network. As the routing performance increases there is increase in the serving qualities of the network. The enhancement is measured in terms of the throughput, energy consumption, packet loss and end to end delay. The flow chart for the proposed algorithm is illustrated in the Figure 3 and 4. In Figure 3 the illustration for initial phase in the network is shown. In this the path is established between the source and the destination, by use of Dijkstra algorithm and also by making the use of available data of residual energy and other resources.

![Flow chat for path selection algorithm.]

In the Figure 4 the illustration is shown when the source node receives the warning message for the local route repair. When the source node receive the warning message it start searching for the alternative path from where it can send the data packets. The path selected should be optimal and shortest path.
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3. Simulations and Result Discussion

The experimental work is done using the NS2 (network simulator) tool. This tool is event based simulator in which different network scenario can be created. Ns2 is an open source, mainly supported on Linux. It support many protocols which helps in creating networks and routing the packets using different routing protocols. Using this simulation network performance measured in terms of throughput, average end to end delay, packet loss and energy consumption. The variation in parameters are analyzed.

CASE I: As the nodes in the network are mobile so there are chances the node may get displaced from its original position when there is an active communication. In our work we are going to compare the performance metrics of AODV\textsuperscript{11} routing protocol for three different scenario. The different scenario are when in the network routing is done using normal AODV protocol, secondly when there is occurrence of the link failure in the network and third scenario in which link prediction is there with AODV routing protocol. Figure 5 shows the comparison among the three different scenarios on the basis of delay. The delay is reduced when the proposed algorithm is used with AODV protocol for routing.

| Parameters                  | Values   |
|-----------------------------|----------|
| Transmitter range           | 200m     |
| Bandwidth                   | 1Mbit    |
| Simulation Time             | 9 sec    |
| Number of nodes             | 24       |
| Environment size            | 600x600  |
| Traffic type                | CBR      |
| Packet rate                 | 5 packets/sec |
| Packet size                 | 512 bytes|
| Pause time                  | 1 sec    |
| Routing protocol            | AODV     |

Table 1. Simulation parameters for AODV with proposed algorithm and link failure condition

Figure 4. Flow chat for sending warning message to the source node and route recovery by the source node.

Figure 5. Variation of delay for AODV.
compared to the other scenario. The throughput increases with increase in the time and also the delay decreases as seen in the above graph. The normal AODV routing protocol has throughput greater than the case when link failure occurs, this happens due to the loss in the packets and increase in the overheads in the network. More will the throughput of the network more will the performance of the routing protocol and more enhanced will be the network and more reliable will the network. Network having the high throughput is always an advantage for the user as reliability of the network increases and better chances of the communication establishment.

Figure 6. Variation of throughput v/s time for AODV.

In Figure 6, the packet loss has been shown. The packet loss occurs more in link failure case as there is breakage in the path. This packet loss increases congestion in the network. But by using the proposed algorithm the packet loss is reduced almost by 75%.

Figure 7. Packet loss v/s time for AODV.

In Figure 7, the packet loss has been shown. The packet loss occurs more in link failure case as there is breakage in the path. This packet loss increases congestion in the network. But by using the proposed algorithm the packet loss is reduced almost by 75%.

From the above all performance metrics it can be concluded that the proposed algorithm has better quality of service parameters and thereby enhancement in the routing performance is done by using the proposed algorithm with the routing protocol. The proposed algorithm has better throughput, low energy consumption, less packet loss and also the delay is reduce.

CASE II:
Next simulation is for the same algorithm for the AOMDV routing protocol. The proposed algorithm is implemented over the AOMDV and the metrics are analyzed. Link failure can also occur in multipath scenario with the aim of enhancement in multipath routing we implemented our proposed algorithm with AOMDV routing protocol and the some of the quality of service parameters are analyzed and hence thereby providing enhancement in the AOMDV routing protocol also. The simulation parameters for the scenario in which routing is performed using the AOMDV routing protocol is given in the Table 2. In the network 24 nodes are deployed and within that network the packets are routed from the source to destination via the ad-hoc on demand multipath distance vector routing protocols. The performance metrics are measured by varying the number of packets in the network with respects to the time. The traffic used in the network is the constant bit rate (CBR). By using the proposed algorithm with the AOMDV routing protocol, the enhancement is provided in the protocol with the enhancement in the quality of service parameters.
Table 2. Simulation parameters for scenario using AOMDV routing protocol

| Parameters          | Values          |
|---------------------|-----------------|
| Transmitter range   | 200m            |
| Bandwidth           | 1Mbit           |
| Simulation Time     | 9 sec           |
| Number of nodes     | 24              |
| Environment size    | 600x600         |
| Traffic type        | CBR             |
| Packet rate         | 5 packets/sec   |
| Packet size         | 512 bytes       |
| Pause time          | 1 sec           |
| Routing protocol    | AOMDV           |

The performance of the network which is using AOMDV routing protocol is measured on the basis of the various quality of service parameters. From the simulation it can be concluded that the performance of the network increases significantly when the proposed algorithm is implemented over the AOMDV routing protocol. Then enhancement in the protocol is done by increasing the performance metrics. In Figure 9 the end to end delay is shown over the variation of number of packets with respect to the time. The AOMDV with the link failure has more delay when compared to the case when the algorithm is used with AOMDV routing protocol. End to end delay in the network should be less, as the packet will reach to the destination without the necessary delay and therefore not affecting the information that sender wants to send to recipient.

Figure 9. Variation of end to end delay v/s time for AOMDV.

In Figure 10 variation of throughput is illustrated. The throughput of the network increases. Throughput for the network is number of packets received at the destination. The throughput for the protocol AOMDV is increases when the proposed algorithm is used.

Figure 10. Variation of throughput v/s time for AOMDV.

In Figure 11, the packet loss in the network is shown with the variation in the number of packets. The number of packets are varied with respect to the time and then the packet loss is analyzed. It has been seen that packet loss is less for the case when the AOMDV routing protocol is used along with the technique to avoid link failure and when there is link failure in the network.

Figure 11. Variation of number of packet v/s time for AOMDV.

Figure 12 illustrates the energy consumed by the network. From the graphs it is concluded that the energy consumption in link failure case is more in comparison to the scenario when link failure is avoided and the packets are routed through another alternative path.

Figure 12. Variation of energy consumption v/s time for AOMDV.
From the outputs it can be concluded that the proposed algorithm performs well with both AODV and AOMDV routing protocol. The quality of service parameters are measured for different scenario so that there will be an enhancement in the routing protocol.

4. Conclusion and Future Scope

The proposed algorithm is implemented using the AODV and AOMDV routing protocol and the simulations is done for various quality of service parameters. The proposed algorithm performs well for both the above mentioned routing protocol. From the simulations it can be concluded that by using the proposed algorithm the routing performance can be enhanced leading to the reliable communication. As the packet loss is decrease and also the network throughput is high. The delay in the transmission of the packet is also reduced extremely. Also the energy consumption by the network is reduced significantly. As power consumption is always an issue in the ad-hoc network so by using the proposed algorithm the power consumption can be reduced by predicting the route failure prior to it actually happens. So by the use of proposed algorithm with both AODV and AOMDV routing protocol there is enhancement in the network performance and also in the routing performance. The algorithm is used with the AODV and AOMDV routing protocol and the enhancement in the routing performance is achieved.

Furthermore other performance metrics can be simulated and analyzed using the same algorithm and the algorithm can be implemented over the other existing routing protocol. The work can be carried out for scenario were more number of nodes are there and the large coverage area.

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