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Energy Efficiency Enhancement of Routing Protocols in MANETS

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Abstract- **The area of mobile ad-hoc networking deals with devices equipped to perform wireless communication and networking, but without any existing infrastructure such as base stations or access points. Networks are formed on-the-fly devices can leave and join the network during its lifetime, devices can be mobile within the network, the network as a whole may be mobile and the network can be deformed on the fly. All this needs to be done without any system administration and without the requirement for any permanent devices within the network. In MANETs, the nodes make the mobile and battery operated. Since the nodes have limited battery resources and multi-hop routes are used over a changing network environment due to behavior of the node mobility, it requires energy aware efficient routing protocols to limit the power consumption, make longer the battery life time and to improve the robustness of the system. In this paper we evaluates the performance of well-known and widely investigated in terms of energy efficiency and it also proposes a new routing algorithm that modifies AOMDV and it provides better performance compared to all the protocols in the presence of scenario with high traffic and long simulation time.**

I. INTRODUCTION

MANETs[1]. is a collection of mobile devices forming a network without any supporting infrastructure or prior organization. Nodes in the network should be able to sense and discover with near by nodes. Routing protocol plays very important part in implementation of mobile ad hoc networks A number of routing protocols using a variety of routing techniques have been proposed for use in MANETs.

II. CHARACTERISTICS OF AD HOC ROUTING PROTOCOLS

The fundamental characteristics of mobile ad hoc routing protocols are exemplified below.

Distributed routing*:* Routing protocols must be fully distributed, as this approach is more fault tolerant than centralized routing.

Adaptive to topology changes*:* Routing must adapt to frequent topological and traffic changes that result from node mobility and link failure.

Proactive/reactive operation*:* The routing algorithm may intelligently discover the routes on demand. This approach will be useful to efficiently utilize the bandwidth and energy resources, but comes with the cost of additional delay. However, in certain conditions, the delay incurred by on-demand operation would be unacceptable.

Loop free routing: Routes free from loops and stale paths are desirable. Perhaps to increase robustness, multiple routes should be available between each pair of nodes.

Robust route computation and maintenance*:* The smallest possible number of nodes must be involved in the route computation and maintenance process, to result in minimum overhead and bandwidth consumption.

Localized state maintenance*:*To avoid propagation of overheads, localized state maintenance is desirable.

Optimal usage of resources*:* The efficient utilization and conservation of resources such as battery power, bandwidth, computing power and memory are required.

Sleep mode operations*:* To reduce energy consumption, the routing protocol should be able to employ some form of sleep mode operation. Nodes that are inactive should switch to “sleep mode” for arbitrary periods.

Quality of Service*:* Routing algorithms are required to provide certain levels of QoS in order to meet specific application requirements.

B. Monet Application

With the increase of portable devices as well as progress in wireless communication, ad hoc networking is gaining importance with the increasing number of widespread applications. Ad hoc networking can be applied anywhere where there is little or no communication infrastructure or the existing infrastructure is expensive or

inconvenient to use. Ad hoc networking allows the devices to maintain connections to the network as well as easily adding and removing devices to and from the network. The set of applications for MANETs is diverse, ranging from large-scale, mobile, highly dynamic networks, to small, static networks that are constrained by power sources.

Military battlefield: The modern digital battlefield demands robust and reliable communication in many forms. Most communication devices are installed in mobile vehicles, tanks, trucks etc. Also soldiers could carry telecomm devices that could talk to a wireless base station or directly to other telecom devices if they are within the radio range.
Sensor Networks: Another application of MANETs is sensor networks. This technology is a network composed of a very large number of small sensors. These can be used to detect any number of properties of an area. Examples include temperature, pressure, toxins, pollutions, etc. Applications are the measurement of ground humidity for agriculture, forecast of earthquakes.

Automotive Applications: Automotive networks are widely discussed currently. Cars should be enabled to talk to the road, to traffic lights, and to each other, forming ad-hoc networks of various sizes. The network will provide the drivers with information about road conditions, congestions, and accident-ahead warnings, helping to optimize traffic flow.
Commercial sector: Ad hoc can be used in emergency/rescue operations for disaster relief efforts, e.g. in fire, flood, or earthquake. Emergency rescue operations must take place where non existing or damaged communications infrastructure and rapid deployment of a communication network is needed. Information is relayed from one rescue team member to another over a small handheld.

Personal Area Network: Personal Area Networks (PANs) are formed between various mobile (and immobile) devices mainly in an ad-hoc manner, e.g. for creating a home network. They can remain an autonomous network, interconnecting various devices, at home, for example, but PANs will become more meaningful when connected to a larger network.

C. Problems in Existing System

AOMDV only addresses the question how to establish multiple routes, but not how to spread the load over them.
AOMDV protocols do not necessarily compute the energy when selecting paths that have lower cost Such protocols must be modified to yield energy-efficient routing solutions.
The mobile devices are battery-powered, extending the network lifetime has become an important objective.
The "death" of even a few nodes, due to energy exhaustion, might cause the disruption of service in the entire network.
Metrics used by AOMDV protocol typically do not have any energy-related parameters.
These algorithms, however, may result in a rapid depletion of the battery energy in the nodes along the most heavily-used paths in the network.
In MANETs, every node has to perform the functions of a router. So if some nodes die early due to lack of energy so that the network becomes fragmented, then it may not be possible for other nodes in the network to communicate with each other.

D. Proposed System

Energy-AOMDV is an extension of AOMDV, The goal behind the proposed protocol is to provide efficient recovery from "route failure" in dynamic network.
To achieve this at the time of route discovery it computes the "power of the receiver node"
It calculates the power to predict pre-emotively before the route failure. EAOMDV predict pre-emotively the route failure that occurs with the less received power.

- The routes with the more power consumption can be avoided, and then selects another path for transmission.
- The energy is goes on checking at every node.

Each mobile node is able to read its own physical residual energy. Each mobile node knows its transmission power, based on which it could estimate the energy consumption of sending a packet. The source node of a request is capable of anticipating the number of packets to be transmitted. Metrics used by E-AOMDV protocol typically have energy-related parameters

III. ROUTING PROTOCOLS IN MANET

Routing protocol in MANET are usually categorized as table driven and on-demand driven depending upon their network structure, communication model, routing approach and state information but for the most part of these are made depending on routing policy and network structure based on the timing of when the routes are updated . The existing routing protocol can be classified into three categories.

Figure 1 Classification of routing protocols in MANETs

A.Table-Driven Routing Protocols

In Proactive-Routing protocols[19], each node has preserves one or more routing tables about nodes in the network. This routing protocol updates the routing table information either periodically or in response to change in the network topology. In this protocol source node does not need route-discovery procedures to find a route to a destination node. On the other hand protocols is maintaining a reliable and updating routing table requires considerable messaging overhead, which consumes power and bandwidth, and decreases throughput, especially in the case of a large number of high mobility of node. Table-driven protocols are DSDV[4], OLSR[12].

B. On-Demand Routing Protocols

The benefit of these protocols is that overhead messaging is reduced. One of the disadvantages of these protocols is the delay in discovering a new route. The different types of reactive routing protocols are: Dynamic Source Routing, Ad hoc On-demand Distance Vector Routing, and Ad hoc On-demand multi-path distance vector routing Algorithm (AOMDV)

In On-demand routing [19] protocols is an initialization of a route discovery method by the source node to find the route to the destination node when the source node has to send data packets. When a route is establish, the route maintenance is initiated to maintain transmission and this route until it is no longer required or the destination is not reachable. These protocols are reduced overhead messages and delay in discovering a new route. On-demand protocols are DSR[6], AODV[3], AOMDV[10]

C. *Hybrid Routing Protocols*

Both the proactive and reactive protocols work well for networks with a small number of nodes. As the number of nodes increases, hybrid reactive/proactive protocols are used to achieve higher performance. Hybrid protocols attempt to assimilate the advantages of purely proactive and reactive protocols. The key idea is to use a reactive routing procedure at the global network level while employing a proactive routing procedure in a node's local neighborhood. ZRP[11],TORA[2]

III. AOMDV OVERVIEW

AOMDV is a multipath extension to its single path predecessor AODV. AOMDV's intelligence lies in its multipath algorithm, which utilizes the already present information in the routing packets. Unlike AODV every time when a link breaks AOMDV doesn't have to reinitiate a route discovery rather it utilizes the next available path in its routing table to forward data packets. Starting from idle state when a node generates a data packet it first traverses through its routing table to find a entry for the desired destination, if it finds a appropriate route entry it looks up for a valid path with a valid next hop and on finding the same it goes into the data forwarding state however if the node is an intermediate node instead of a source and somehow receives a data packet it will as well look through the route table and if it doesn't find an appropriate entry it goes into the route maintenance state wherein it generates a RERR and send it to the upstream node, and the upstream nodes as well as the source on arrival of the RERR packet deletes the next hop from the path entry. The node goes in to local connectivity maintainer phase when in receives a hello message from one of it neighbor. In this phase the node updates it neighbor table and it routing table as per the hello message received.

1.ADVANTAGES

- Multiple paths Routing algorithm
- Routes are established on demand and destination sequence numbers are used to find the latest route to the destination.
- Lower delay for connection setup.

2.DISADVANTAGE

- Metrics used by AOMDV protocol typically do not have any energy-related parameters.
- These algorithms, however, may result in a rapid depletion of the battery energy in the nodes along the most heavily-used paths in the network.

IV. E-AOMDV OVERVIEW

Energy -AOMDV:The thought behind the modified protocol is to find the nodal residual energy of each route in the procedure of selecting path and select the path with minimum nodal residual energy and sort all the routes based on the descending order of nodal residual energy. Once upon a time a new route with greater nodal residual energy is rising it is again chosen to forward rest of the data packets. It can develop the individual node's battery power operation and hence extend the entire network's lifetime.

For improving the lifetime of whole network has some following steps are involved:

- Find the nodal residual energy of each route in the route discovery procedure.
- Find the valid route with minimum nodal residual energy.
- Set in order all the routes based on the descending value of nodal residual energy
- Make a decision on the route with minimum nodal residual energy to forward the data packets.

In this approach, we have selected various routing protocols such as AODV, DSR, DSDV, TORA and AOMDV are

contrasted with respect to more metrics and proposed a new routing algorithm that modifies AOMDV protocol therefore it consumes minimum energy compared to AOMDV protocol. In this protocol performances are checked in higher mobility situations. In this approach tries to optimize delay, bandwidth, overhead and reflects much better the topological change. Energy Routing protocols are analyzed in terms of energy efficiency. The E-AOMDV protocol has two main components.

a) Discovery route minimal nodal residual energy of each route in the route discovery process.

b) Arranging multiple-route by descending nodal residual energy and use the route with minimal nodal residual energy to forward data packets.

V. DESIGN MODEL

This section describes the design decisions and strategies that affect the overall organization of the system and its higher-level structures. These strategies should provide insight into the key abstractions and mechanisms used in the system architecture.

The Overall module of the system is as shown below.

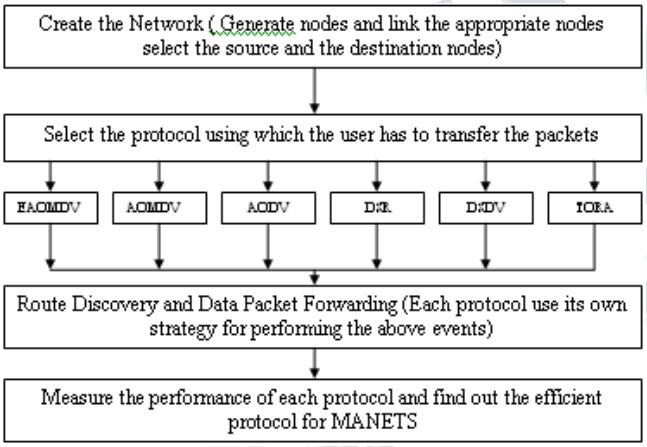


Figure 2: Overall System Module

Network Creation Module : The required number of nodes and their links are created

Routing Module : The User Desired Protocols are selected to perform routing of packets from source to destination

(Each protocol in routing module has to perform data transfer from source to destination if there is a valid path but if no path exits then route discovery is initiated and data is forwarded in the new path)

Performance Module : The performance of the protocols are measured based on various metrics (Throughput, Energy consumed, packet loss, etc)

A. Network creation Module

In the network creation module first the number of nodes needed is created and then the link between each node is created. The source node and the Destination node is selected and the packets are transferred from the source to destination if there is a valid route else the route discovery process begins which finds the best route among the various route and uses it to transfer the packets from the source to destination.

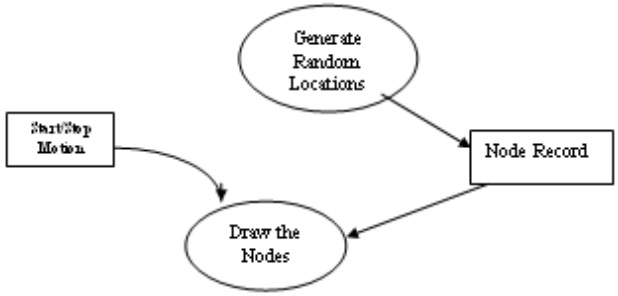


Figure 3 DFD for Network creation module

B. EAOMDV Protocol (Route Discovery)

1. Route update

EAOMDV uses route update rule to establish and maintain stable multiple *loop-free* paths at each node.

2. Route Discovery

EAOMDV uses the Route Discovery method to discover the multiple node-disjoint paths. The route discovery uses the 2 different phases. Route Discovery phase and Route Reply phase. The Route Request phase is used to discover the path it broadcasts the RREQ packets. When an intermediate node receives the RREQ it performs following ***Steps.***

Step 1: The Residual energy of each node is calculated.

Step 2: The sum of residual energy of all the path is calculated.

Step 3: The routes with minimum residual energy is used as a valid path to transfer the data packets

1.Route Request (RREQ)

2.Route Replies (RREP)

These two messages are used to discover the route across the network by using the UDP packet. When a node requests to locate a route, it sends its IP address as a source address and the message IP header is broadcasted. The TTL in IP headers determine the number of hops for the message. To start a route discovery procedure a RREQ packet is broadcasted. RREQ message have destination sequence number request that avoid the replication of old information and looping problem, which is necessary to the traditional distance vector protocols. It doesn't add any new information of passed hosts but only increases its hop metric. Each host that is passed update own routing table, so

destination reply to be easily routed back is helped by host on request.

RREP message is used for this connection. When a node receives the RREQ packet it creates a reverse route to the sending node. RREQ is updated with one more hop count from the source. Nodes which receive the RREQ check whether it has an active route to the destination. If it contains no information about the destination, the node rebroadcast the RREQ packet. In this way RREQ is flooded throughout the network. When a node forward RREQ to its neighbor, routing table is updated so that if this packet arrive again it can be discarded. When RREQ packet reaches the destination, RREP packet is generated from the destination node or intermediate node used the established reverse path.

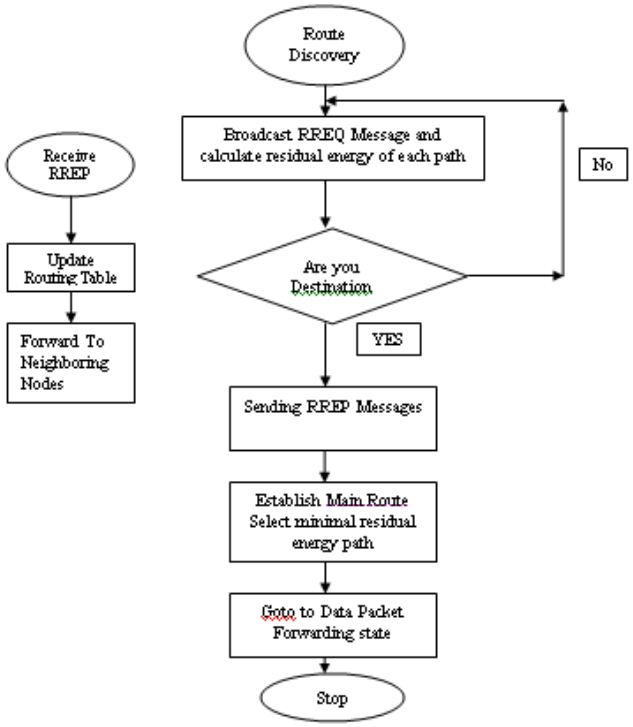


Figure 4: EAOMDV Route Discovery

C. EAOMDV Data Packet Forwarding

When an application at the source node generates a data-packet and it reaches the routing layer it first looks up in its routing table for a matching entry to the concerned destination.AOMDV forwards data packets on a particular path to the destination node.

If a link failure is reported by the MAC layer or the path is removed due arrival of RERR then it simply switches to the next path in the list and starts forwarding data packets. But if it has no path to destination then it initiates a route discovery process and finds a new path to the destination

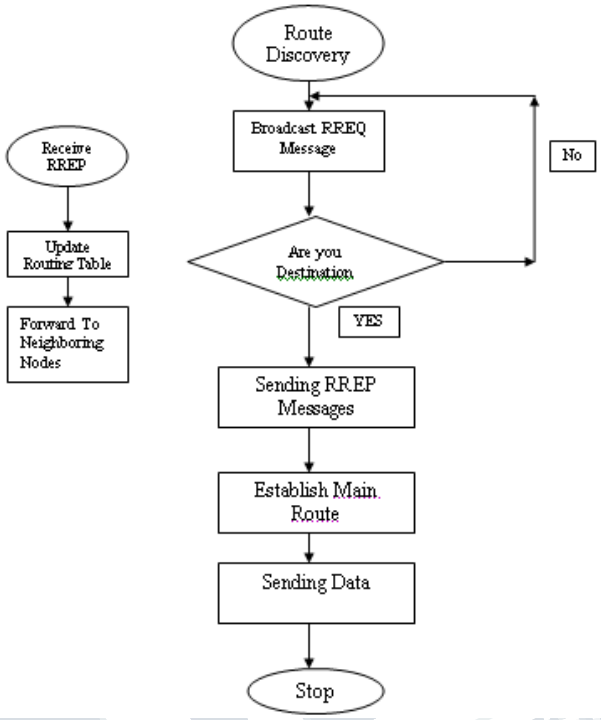


Figure 5: EAOMDV .Data Packet Forwarding

VI. FLOW CHART

A flowchart is a common type of diagram, which represents an algorithm or process, shows the flow of control through an algorithm, allowing a reader to determine what operations will be performed, in what order, and under what circumstances, but not what kinds of data will be input to and output from the system, nor where the data will come from and go to, nor where the data will be stored.

A. System Flow Chart

The Figure 5 shows system flow chart where the sender initiates a data transfer to the receiver.

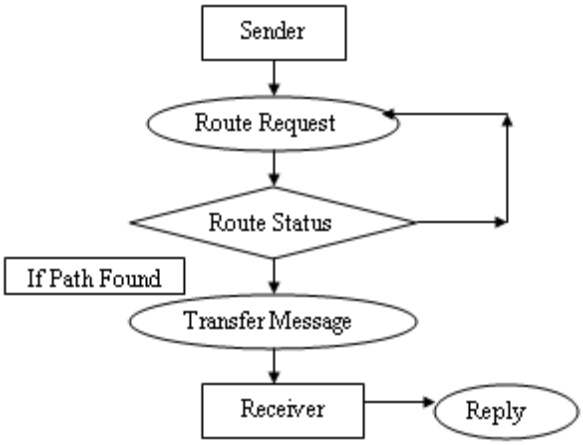


Figure 6 : System Flow Chart

B. Detailed Flow Chart

The flowchart given below shows the complete working of the system we start by creating the nodes to form a manet network then the user has to link the nodes in the network. The source and the destination link has to be selected then the user has to select the protocol using which he has to transfer the packets. The protocols available are EAOMDV(Energy Adhoc On Demand Multipath Distance Vector)
AOMDV(Adhoc On Demand Multipath Distance Vector)
AODV(Ad hoc on Demand Distance Vector)
DSR (Dynamic Source Routing Protocol)
DSDV(Destination Sequenced Distance Vector)
TORA(Temporally Ordered Routing Algorithm)
Based on the protocol selected the routing is performed and performance of the protocol is measured and compared with other protocols.

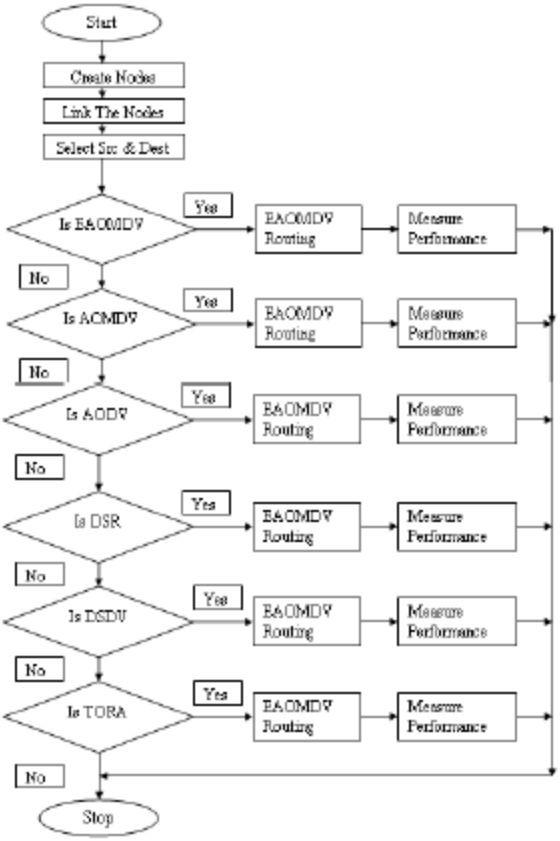


Figure 7 : Detailed Flowchart

VII. TESTING STRATEGY

The test strategies that are used for software testing in the project have the following details:

- Features to be tested

Features to be tested mainly contain the important features of the individual unit of the project. It also contains the selection of proper input to test the functionality or feature of the unit.

- Assumptions and constraints

While executing some of the test cases some parameters required for execution are assumed as some of the modules or functions will depend on the output of other module or function. These assumptions or constraints are clearly specified in the test cases.

A. Unit testing

Individual component are tested to ensure that they operate correctly. Each component is tested independently, without other system component. This system was tested with the set of proper test data for each module and the results were checked with the expected output. Unit testing focuses on verification effort on the smallest unit of the software design module. This is also known as module testing. This testing is carried out during phases, each module is found to be working satisfactorily as regards to the expected output from the module.

B. Integration Testing

Integration testing is another aspect of testing that is generally done in order to uncover errors associated with the flow of data across interfaces. The unit-tested modules are grouped together and tested in small segment, which makes it easier to isolate and correct errors. This approach is continued until all the modules are integrated to form the system as a whole.

C. Validation Testing

At the culmination of integration testing, software is completed and assembled as a package. Interfacing errors are uncovered and corrected. Validation testing can be defined in many ways.

D. User Acceptance Testing

User Acceptance of a system is the key factor for the success of any system. The system under consideration is tested for user acceptance by constantly in touch with the prospective system users at time of developing and making changes wherever required is done in regard to the following point:

- Input Screen design
- Output Screen design
- Menu driven system

E.Output Testing

Output testing of the proposed system is very much essential as no system could be useful if it does not produce the required output in the specified format. Asking the users about the format required by them tests the outputs generated or displayed by the system under consideration. Hence the output format is considered in two ways - one is on screen and another in printed format.

F. System Testing

System testing is actually a series of different tests whose primary purpose is to fully exercise the computer-based system. Although each test has a different purpose to verify that all system elements have been properly integrated and perform allocated functions.

Testing is the final verification and validation activity within the organization itself. In the testing stage, the following goals are to be achieved; to affirm the quality of the product, to find and eliminate any residual errors from previous stages, to validate the software as a solution to the original problem, to demonstrate the presence of all specified functionality in the product, to estimate the operational reliability of the system. During testing the major activities are concentrated on the examination and modification of the source code.

VIII. TESTING RESULTS

The manet network was created with 5 nodes as shown

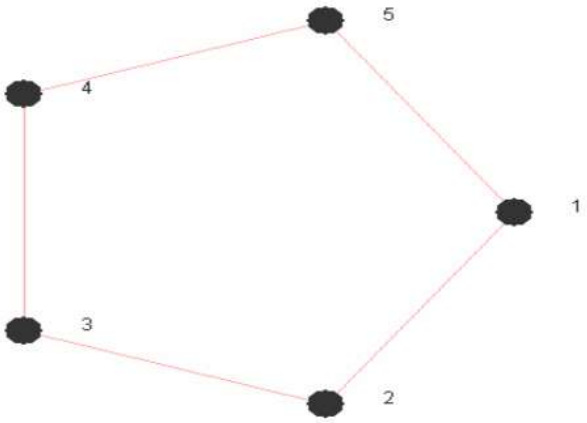


Figure 8 : Manet Network

The source node is 1 and the destination node is set to 4 and our EAOMDV protocol was tested there was two path founded that is

- 1-2-3-4
- 1-5-4

The energy consumed by the fist path is 800J and the energy consumed by the second path is 1200J so the path with minimal residual energy is selected by this protocol as shown below

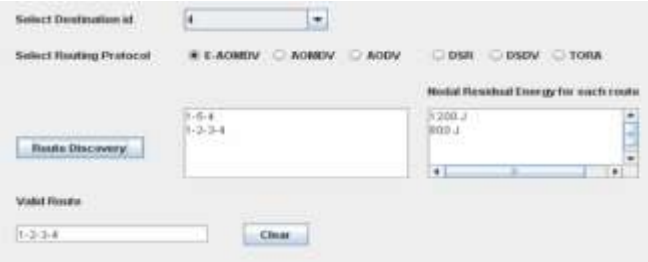
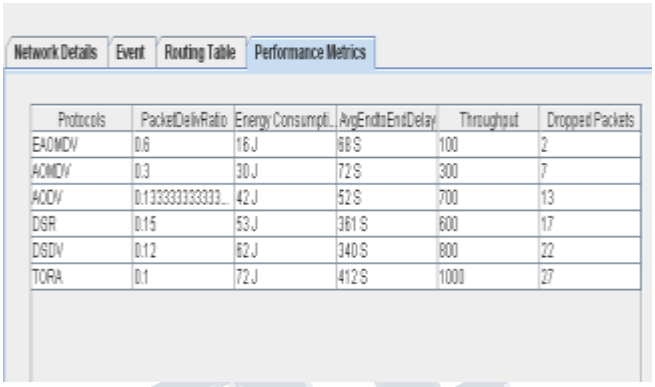


Figure 9 : Energy Calculation

Therefore the best path is 1-2-3-4 and this is used to transfer packets and the performance measurement of the node with respect to the performance metrics is shown below. The table also shows the performance of other protocols using the same network and the source and the destination node.



Protocols	PacketDelivRatio	Energy Consumpti..	AvgEndtoEndDelay	Throughput	Dropped Packets
EAOMDV	0.6	16 J	66 S	100	2
AOMDV	0.3	30 J	72 S	300	7
AODV	0.133333333333..	42 J	52 S	700	13
DSR	0.15	53 J	361 S	600	17
DSDV	0.12	62 J	340 S	800	22
TORA	0.1	72 J	412 S	1000	27

Figure 10 : Performance Comparison

The performance metrics are Packet Delivery Ratio, Energy Consumption, Average End to End Delay, Throughput, Dropped packets.

IX. CONCLUSION

This project compared the performance of single path and multipath on demand protocols in order to provide efficient routing. we have simulated and compared the reactive protocols EAOMDV, AOMDV, AODV, DSR, DSDV, TORA in different simulation scenarios and observing their behavior in terms of six significant parameters i.e. Packet delivery Ratio, Average end to end delay, Packet Drop, Energy Consumed and throughput in order to find out which one should be preferred when the mobile adhoc network has to be set up for the particular duration.

By analyzing the parameters Packet delivery ratio, average end to end delay and throughput, we come to this conclusion that EAOMDV must be preferred over all the other protocols since it outperformed due its ability to search for alternate routes based on residual energy. Simultaneously, finding multiple paths in a single route discovery reduces the routing overhead incurred in maintaining the connection between source and destination nodes. Multipath routing can provide load balancing and reduce the frequency of on-demand route discovery. The simulation results show that the proposed scheme is better than all the other protocols in discovering and maintaining routes. The performance analysis shows that the frequency of an on demand route discovery for multipath routing is less than that for single path routing. Our future work intends to be in the direction of simulating the protocol for secure multipath routing.

FUTURE ENHANCEMENTS

In the future, the work can be extended on the other multipath routing protocols or with hybrid routing protocols in order to find the appropriate protocol suitable for different scenarios. It can be further extended by implementing the scenario with the different mobility models, different network and traffic scenarios and observing the behavior of protocols by varying the pause time. Also the behavior of the protocols can be studied further by varying the parameters like number of mobile nodes, the topology area, choice of the traffic type between the mobile nodes.

The continuity of this work could be accomplished through the evaluation of others routing protocols (secure and not secure) particularly multipath routing protocols. Impact on QoS can be analyzed, using different mobility patterns, because due to the increase in mobility, the degradation in values of QoS metrics can be there. Another work that can be carried out is to analyze the security of routing protocols in an Ad hoc network.

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