Energy Optimization in MANET Using Load Balancing & Different Routing Techniques

A dissertation submitted in the partial fulfillment for the award of Degree of

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In

Software Technology

By

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DECLARATION

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I hereby declare that the thesis entitled, "**Energy Optimization in MANET Using Load Balancing & Different Routing Techniques**", a bona fide work done by me in partial fulfillment of requirements for the award of Master of Technology Degree in software technology at Delhi Technological University (New Delhi) is an authentic work carried out by her under my supervision and guidance. The matter embodied in the thesis has not been submitted to any other University / Institute for the award of any Degree or Diploma to the best of my knowledge.

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This is to certify that the thesis entitled, "**Energy Optimization in MANET Using Load Balancing & Different Routing Techniques**", a bona fide work done by **Mr. Ravinder (2K13/SWT/13)** in partial fulfillment of requirements for the award of Master of Technology Degree in software technology at Delhi Technological University (New Delhi), is an authentic work carried out by her under my supervision and guidance. The content embodied in the thesis has not been submitted to any other University / Institute for the award of any Degree or Diploma to the best of my knowledge.

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I have given ample time and guidance to complete my project under timeline defined by the university. This project has given me opportunity to explore the domain of Software Engineering.

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ABSTRACT

Routing protocols are required in network for deliver packets from source to destination. The multipath routing provides concept of load balancing but not efficiently distribute the load in network by that the valuable source of communication i.e. energy conservation is affected from it because of packet loss etc. This project is motivated by the idea of taking account of several factors in Mobile Ad hoc Networks (MANET) routing design in a unified manner. The rational of our motivation is that most of the multi path routing protocols are designed only based on one criterion, i.e., shortest path considered with balance load and energy conservation. We proposed a scheme which could consider energy conservation, shortest path and load balancing. In this routing scheme, we shall consider both the shortest path and the energy conservation in multipath way with proposed energy based multi path routing (E-AODV/E-DSR). We have defined an energy factor as that we will use the products of the energy factors of all the nodes along different paths as mentioned by the selection criteria.

The energy factor informs about the status of energy then here we evaluate the performance of normal AODV/DSR and energy based E-AODV/DSR. The life times of proposed energy based AODV/DSR are limited but the improved routing as compares to AODV/DSR without the including energy factor.

The performance of proposed scheme are better in limited life time frame. The performance matrices are shown the better results in the proposed scheme.

Chapter 1

1 Introduction

1.1 Introduction and Motivation

A Mobile Ad hoc Network (MANET) is a collection of mobile nodes relying neither on fixed communication infrastructures nor on the any base stations to provide connectivity. Each node in the MANET network topology acts both as host and a router. If two nodes are not within the transmission range of each other, other nodes are needed to serve as the intermediate routers for the communication between the given two nodes. Here the hosts are free to move around randomly, and hence the network topology may changes dynamically over time. Therefore, the routing protocols for a MANET must be adaptive and capable of maintaining the routes as the characteristics of the network connectivity changes. Designing an efficient and reliable routing protocol for such networks is a challenging task. For this reason, many routing protocols have been developed, trying to accomplish this process efficiently. Since mobile ad hoc networks changes their topology frequently, routing in such networks is challenging task. Multipath routing may improve the system performance through load balancing and reduced the end-to-end delay. New route discovery is needed only when all paths get fails. This reduces both route discovery latency and routing overheads.

Multiple paths can also be used to balance load by forwarding data packets on multiple paths at the same time, though we will not investigate this aspect in our work. Efficient ad hoc network protocols can then support multipath concept with energy constraints to return data effectively & efficiently without incurring the high operation costs to coordinate and communicate with a large number of small, constrained elements. The original scheme showed an uneven distribution of energy consumption among nodes close to the neighbor and some nodes constantly use the more energy than others. Those are the nodes that were heavily involved in forwarding packets. If this trend continue, these nodes will die much earlier than the others and will cause the disconnection of network. Traffic load balancing is another issue which would affect the energy in the network system. A routing protocol that does not take into account of traffic load balance will result in the usage of paths that are already heavy in traffic loads. It will add more burdens on the energy consumption to these paths and indirectly lead to imbalanced energy consumption of the whole network.

The nodes in a high traffic load path will 'die' off faster than other nodes in paths that have lower traffic load. Thus load awareness routing provides not only a lower end-to-end delay, but also indirectly leads to the more efficient energy distribution routing.

In this project, we proposed a simple routing scheme which could consider power conservation, shortest path and load balancing in traffic. The key challenge is to design routing protocols that are not only considering energy balance but also carry out the routing process in an efficient way, i.e., the path is shortest. In another word in this routing scheme, the criteria for finding a path should consider both shortest path, power and the traffic load balancing in a unified way.

1.2 On Demand Distance Vector Protocol

In this type of protocols, routes are created only when required. In other words, when a packet is to be transmitted from a source to a destination, it invoke the route discovery procedure. The route only remains valid till either the destination is reached or the route is no longer required. Some of the existing on demand routing protocols are: DSR and AODV etc.

The AODV/DSR are on demand routing protocol based on distance vector concept and uses hop-by-hop routing approach to carry out the transmission. In the route request packet (RREQ) propagation from source towards the destination establishes multiple paths both at intermediate nodes as well as the destination node. Multiple route reply packet (RREPs) traverse these reverse paths back to source at the destination and intermediate nodes. These distance vector protocols guarantees loop freedom and the disjoint of multiple paths by formulating certain rules in which every node in the traffic network must observe. In order to maintain multiple paths for the same sequence number, AODV/DSR uses the notion of an "advertised hop count". Every node in the network is required to maintain this variable for each destination. This variable is set to the length of the longest available path for the destination at time the first advertisement for a particular destination sequence number. The advertised hop count remain unchanged until sequence number changes. The use of the longest route allows more number of alternate paths to be maintained while enforcing the route advertisement rule. Apart from maintaining multiple loop free paths in the network, these protocols ensures that alternate paths are disjoint so that they are more likely to fail independently.

First, confirm that you have established connection from destination and maintained the multiple routes for alternative option in the network traffic.

1.3 Related Work

This section represents the work that has been done in this field. This project presented a congestion adaptive multi path routing protocol to increase the throughput and avoid congestion in MANET's topology. In this approach when the average load of an existing link increases beyond a defined threshold and the available bandwidth and the residual battery energy decreases below a defined threshold, traffic is distributed over fail-safe multiple routes to reduce the traffic load on a congested link.

The Predictive Energy-efficient Multicast Algorithm take the advantage of network statistical properties in resolving scalability and overhead issues caused by the large scale MANETs as opposed to relying on route details in network topology. The running time of Predictive Energy-efficient Multicast depends on the multicast group size instead of network size, hence, this resulted in PEMA to be fast enough for MANETs that consisting of more than 1000 nodes. The results of simulation shows that PEMA post appreciable power savings compared to the other existing algorithms, it also attains good packet delivery ratio in the mobile environments. What makes PEMA so different is its speed, it is extremely fast as its running time is independent of its network size and the routing decision result does not rely on the information about network topology or route details.

Power aware routing (PAR) maximizes the network life span and minimizes the energy utilization by selecting less congested and more stable route, during the source to destination route establishment process to transmit the data packets, hence, providing energy efficient routes. The three parameters focused by the PAR protocol as: Accumulated energy of a given path, status of the battery lifetime and type of data to be transmitted in the network. These core metrics are the focus of PAR during route selection time, hence less congested & more stable routes for data delivery is considered. Thus, network lifetime is increased if different routes for the different type of data transfer are provided. The results from the simulation shows that PAR outperforms related protocols such as DSR and AODV, with respects to the diverse energy-related performance metrics even in high mobility scenarios. Nevertheless, PAR incurs increased latency time during data transfer, but it discovered the route will last for a long time and the enormous energy saving in the network.

The proposal has 3 phases: RREQ (Route Request) phase, RERR (Route Errors) and local repair phase. Power related function occurs with RERP(Rout Reply) only because in the beginning all the nodes will be in the fresh mode so there is a full power to find route and send the request message & also all the nodes which are not participating in route request go to sleep mode.

A triangular energy saving cache based routing protocol by sieving (TESCES) was proposed by it is a kind of energy aware and location aware grid based protocols in MANETs. It was based on the two protocols: a fully energy aware & location aware protocol (FPALA) and an energy saving cache based routing protocol (ESCR). In this protocol network is divided into grids depending on GPS. TESCES has three procedures:

1. GLEES to elect leader node with maximum energy for each grid in network, while some nodes join a grid leader election, other nodes will be in sleeping mode.
2. CGLM for maintain grid leader & new grid leader is candidate from cache table directly.
3. TESRD for saving the routing discovery and chose the path with minimum nodes.

In the modified DSR algorithm, destination chooses path through which the first RREQ message arrived to the destination, and send the RREP message through same path while ignoring the other paths, and this path will be chosen by source to send the data packets because this is fastest path. This leads to decrease in the end-to-end delay, reduce control packets generated and maximize the packet delivery ratio. The modified DSR also overcome overheads drawback of existing DSR, by reducing the header of data packet. Header of data packet now include only source and destination address, while previously it includes source and destination address as well as all the intermediate nodes address between source and destination. It proposed a novel power and the battery aware routing protocol, which not only incorporates the effect of power consumption in routing a packet and recent traffic density at each node but also exploits charge recovery effect phenomenon observed in the batteries. Route selection is based on a cost metric, which captures the residual battery capacity and drain rate of mobile nodes in the network. In particular, they are exploring impact of nodes having only inaccurate/imprecise knowledge of the energy levels of other nodes. They use two different energy efficient variants of the OLSR protocol and simulate a wide range of scenarios.

1.4 Problem statement

Multipath routing protocols are provided the alternative path from source to destination by the load in network distributed but only multipath routing are not essential for load distribution. If load are not distributed properly, then in that case the limited life of node i.e. energy are wasted for retransmission of packets, then the proposer load balancing and efficient energy consumption are the main issue in this research.

1.5 Approach

This section provides overview of the approach adopted to provide solution of the problems mentioned above. There are basically two modules that work to achieve the required target. The output from one module is fed as input to another module and the result is our target goal to provide the proposed methodology.

1.6 Organization of the thesis

The structure of thesis in terms of the contents of its various chapters is as follows.

Chapter 2: This chapter provides the overview of Mobile Ad-hoc Network topology.

Chapter 3: This chapter provides the overview of different Routing techniques, their pros, cons etc. used in the given project.

Chapter 4: This chapter provides the details of proposed methods, implementation and Simulation Environment parameters.

Chapter 5: In this chapter we give the energy comparison with different Routing Protocols & Simulation results.

Chapter 6: This chapter is for the conclusion of the thesis.

Chapter 2

2 Background Study

2.1 Mobile Ad-hoc Network

Recently, wireless networks and mobile devices gained a wide popularity through the world. This has led to the significant increase of mobile ad-hoc networks in last few years. Accordingly, MANET's architecture became one of the most prevalent areas in the research. The ability of this type of networks to operate anywhere and anytime made it adaptable in many new applications. In general, there are two communication approaches for the wireless mobile nodes. Here they are:

- **Infrastructure-based**: wireless mobile networks: these are based on cellular concept. They rely on a good infrastructure support. Mobile devices communicate with an access point, such as a base station, which in turn is connected to a fixed network infrastructure.
- **Infrastructure-less**: MANETs belong to this type of communication. It consists of a collection of wireless dynamic nodes that form a network. The nodes exchange the information without using any pre-existing fixed network infrastructure.

  In this infrastructure-less approach, all nodes cooperate with each other to forward packets; thus extending the limited transmission range of each node's wireless network interface. Each node may forward traffic unrelated to its own use, and therefore be a router. Each node in a MANET is free to move independently in any of the direction, and therefore changes its links to other devices frequently. Due to this dynamic nature of the MANETs, routing protocols should be efficient enough to satisfy the whole network's requirements.

2.2. Topology in Network

A mobile ad-hoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless communication to each other. They are characterized by the following criteria:

- **Dynamic topology:** In this topology, Nodes are free to move arbitrarily, meaning that the network topology, which is typically multi-hop, may change the randomly and rapidly predictable times.

- **Bandwidth limited and fluctuating capacity links:** Wireless links, by nature, have substantially lower capacity as compared to their hard wired counterparts. Besides the throughput of a wireless communication in the real environment is often much lower than a radio's maximum transmission rate. This is due to existence of multiple negative effects such as fading, noise & interference conditions.

- **Low power and resource:** Mobile nodes are likely to be rely on batteries. Therefore, primary design criteria should be energy conservation.

- **Constrained physical security**: Mobile wireless networks are more likely to be the vulnerable to physical security threats than are fixed cable nets. For e.g., there is an increased possibility of the eavesdropping, spoofing, and denial of service attack that should be carefully considered in network.

- **Decentralized network control:** the decentralized nature of network's control in MANETs supports extra robustness against single points of failure found in centralized approaches.

2.3. MANET Applications

Due to their flexible nature, MANETs are used in many applications such as:

- Sensor Networks for environmental monitoring
- Rescue operations in remote areas
- Remote construction sites
- Emergency operations

- Military battlefield
- Civilian environments
- Law enforcement activities
- Commercial projects

2.4. Challenges in MANETS

- **Routing:** since the topology of network is constantly changing, the issue of routing packets between any pair of nodes becomes a challenging task. Furthermore, multicast routing even imposes bigger challenge because multicast tree is no longer static. This is due to random movement of nodes within the network. Routes between nodes may potentially contain the multiple hops. Therefore, the design of the protocol become even more complicated.
- **Power Consumption:** Routing protocol should take into consideration the limited power resource of the mobile wireless nodes. In other words, routing protocol should be efficient and energy-aware.
- **Internetworking:** a MANET may be inter connected with a fixed network. Therefore, the routing protocol should take into consideration the coexistence of other routing protocols designed for the fixed networks.
- **Security and Reliability:** In addition to the common vulnerabilities of the wireless connection, an ad hoc network have its particular security problems due to nasty neighbor relaying packets. The feature of distributed operation required different schemes of authentication and key managements. Furthermore, wireless link characteristics introduce reliability problems, because of the limited wireless transmission range, the broadcast nature of the wireless medium (e.g. hidden terminal problem), mobility -induced packet losses, and data transmission errors.
- **Quality of Service (QoS):** Providing different quality of service levels in a constantly changing environment imposes a further challenge.

Chapter 3

3 Routing Protocols

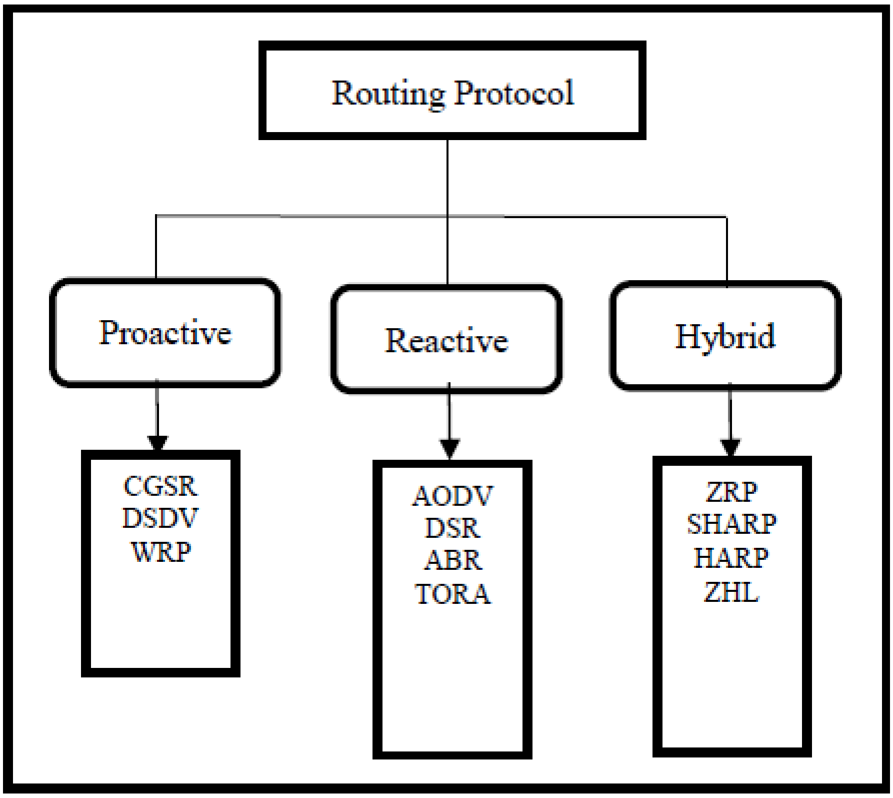
Several MANETs routing protocols are proposed in the literature. These may be broadly classified into two types as:

1. **Table Driven or Proactive Protocols**: In this type of protocols, each node in network maintains one or more tables containing routing information to every other node. All nodes keep on updating their routing tables to maintain the latest view of the network. DSDV is an example of this type protocols.

2. On Demand or Reactive Protocols: In this type of protocols, routes are created only when required in network. In other words, when a packet is to be transmitted from a source node to a destination node, it invokes route discovery procedure. The route remains valid till either the destination is reached or the route is no longer needed. Some of the existing on demand routing protocols are: DSR and AODV.

3. Hybrid routing protocols: They combines the proactive and reactive protocols, which will gives a better solution when compared to a particular routing protocols. Each node proactively maintain a routing table for nodes and reactively finds a route to its destination. Some protocols are ZRP, ZHL.

This project emphasizes on DSR and AODV routing protocols since it was proven that these are the best suited for on demand Ad Hoc Networks. The next sub sections describe the basic features of these protocols.



MANET Routing Protocols

Parameters	Proactive	Reactive	Hybrid
Route availability	Always required	As per need	Depends on location of destination
Routing information	Stored in table	Do not store	Depends on requirement
Storage requirements	Higher	Depends on number of routes needed	Depends on size of each zone or cluster
Periodic updates	Always required	Not required	Used inside each zone

Comparison of Ad hoc Routing Protocols

3.1 Ad Hoc on-Demand Distance Vector Routing (AODV)

AODV uses traditional routing tables, one entry per destination. This is in contrast to DSR, which maintains multiple route cache entries for each destination. Without source routing, AODV relies solely on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination in network to determine freshness of routing information and to prevent routing loops. All the routing packets carry these sequence numbers. An important feature of the AODV is the maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. A set of predecessor nodes are maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets. These nodes are notified with RERR packets when the next-hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all the routes using the broken link. In contrast to the DSR, RERR packets in AODV are intended to inform all the sources using a link when a failure occurs. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves.

1) AODV Advantages:

1. Very effective in highly dynamic networks topology.
2. Since the information of stale routes expire after a specific time, AODV requires less space as compared to other reactive routing protocols.
3. Supports multicasting in network.

2) AODV Limitations:

1. AODV lacks in an efficient route maintenance technique since routing information are always obtained on demand.
2. Like DSR, AODV suffers from high route discovery latency.
3. As DSDV, a big overhead is imposed on the routing protocol due to large number of control overheads. These are necessary to send route reply messages for single route request.

Routing of packets in AODV

In this protocol, the route is established when the source node wants to transmit data pocket at destination node. AODV basically uses the sequence numbers on nodes for fresh routes. When the node wants to broadcast a request at that time it establish a connection. During transmission of pocket if connection goes down, it generates a route error and passed back to a transmitting node and process is repeats until to find a new routes.

In AODV routing protocol, the source node and an intermediate nodes store the next hop into each flow of data packet transmission. AODV protocol determines, up to date path information to the destination using destination sequence number. It has a ‘time to live’ feature at route request node to check how many times the packets can be retransmitted in the network.

AODV does not create any extra traffic for communication with existing routes is the main advantage here. Another advantage of the protocol is that, it establish a route on demand, means when required and destination sequence numbers are used to find the latest route for the destination. Disadvantage of AODV is unnecessary bandwidth consumption because of periodic beaconing in the network. A multiple route-reply packets in response than a single route-request packet can lead to heavy control overhead. The AODV routing reduce the control traffic message overhead at cost of increased latency in terms of the finding new routes. In this routing, the destination node reply only once when the exiting requests is ignored and respond only first request. Per destination at the most one entry is maintain in routing table.

In AODV routing, when a route to a new destination is necessary at that time source node broadcast a RREQ message to find a route for destination. An intermediate node receives RREQ replies to the source node using route reply message only if it has route to the destination along with destination sequence no. is greater or equal to one contained in the RREQ. RREQ contains a most recent sequence number for the destination of which the source node is responsive. If it unicast RREP reverse to the source with RREP packet means route error packet. Otherwise, it rebroadcast the RREQ for the same.

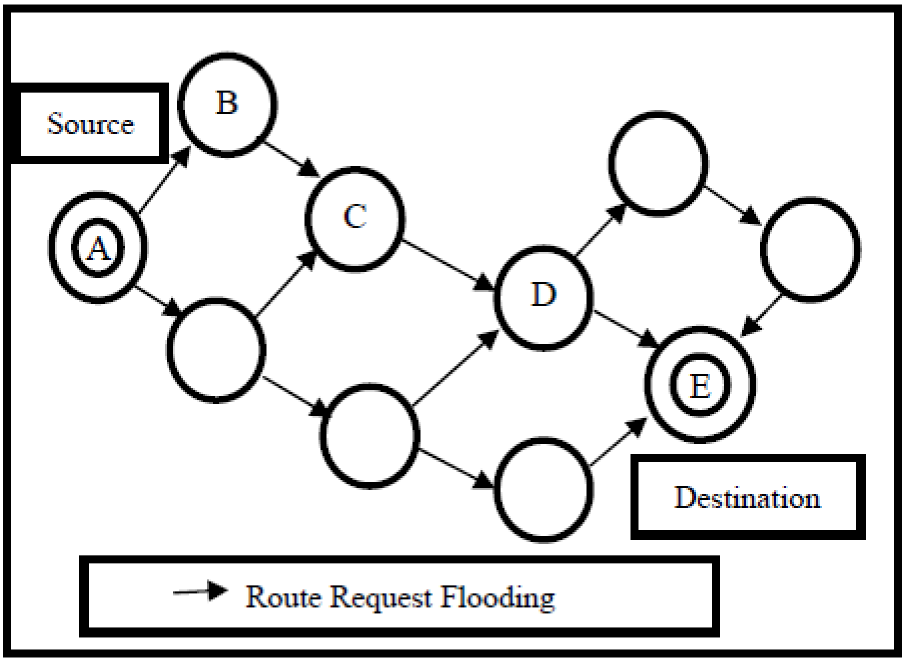


Fig 2: Route Request (RREQ) packet

Fig: 2 and Fig: 3 shows how the routing packets transfer with RREQ packets and reply with RREP packets in route discovery phase.

In route discovery phase, packets are transfer from source node to destination node with the help of other intermediate nodes for finding new routes to reach at destination. But, here AODV routing protocol is main focus on route maintenance phase than other reactive routing protocols.

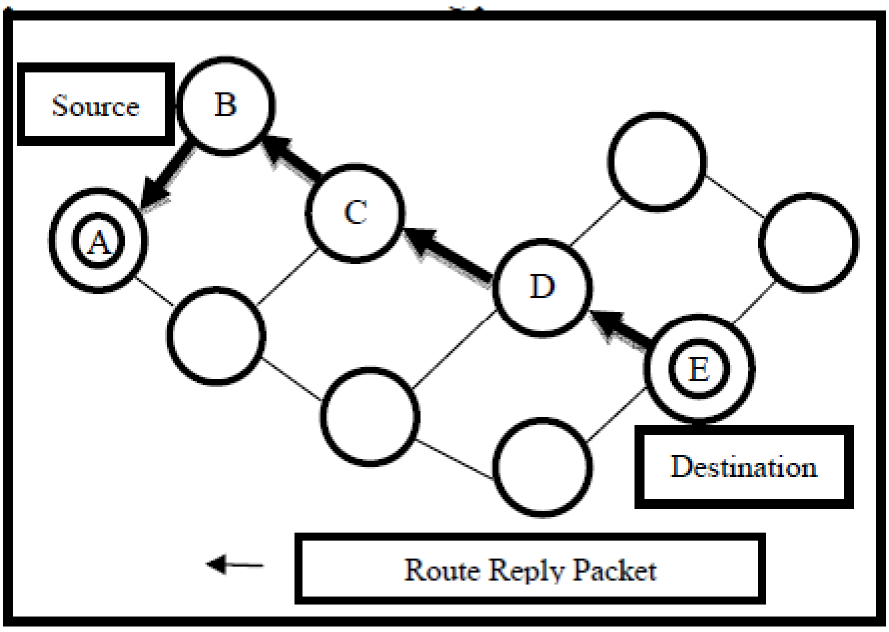


Fig 3: Route Reply (RREP) Packet

Fig: 4 shows the error message using RERR packet in route maintenance phase time. In, the route discovery phase route request (RREQ) and route reply (RREP) packets are considered but in route maintenance phase route error packet is generated because of failure of route or connection. Route reply process is same as route request but it is done in reverse order.

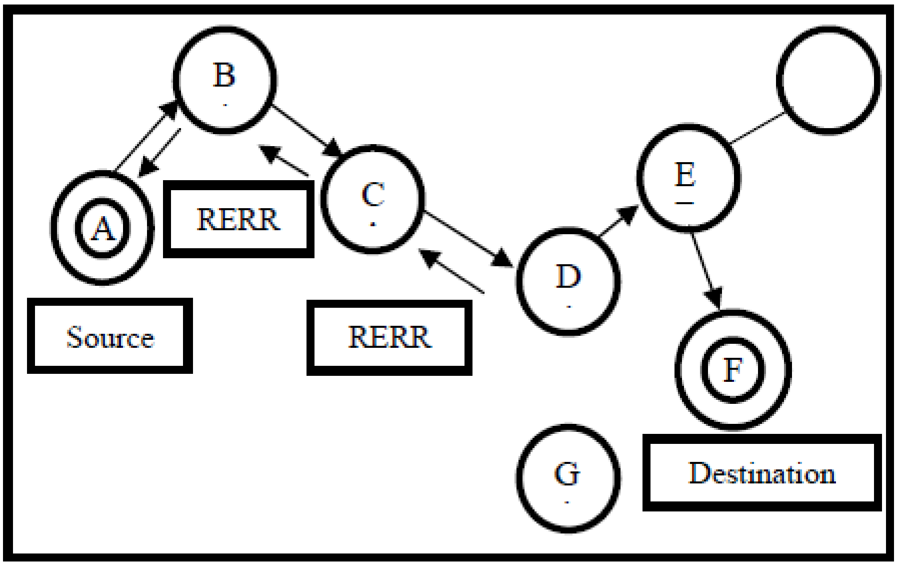


Fig 4: Route Error (RERR) Packet

3.2 Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) is an Ad Hoc routing protocol based on theory of source-based routing rather than table-based. DSR protocol is source initiated. This is particularly designed for use in the multi hop wireless ad hoc networks of mobile nodes. Basically, DSR protocol does not need any existing network infrastructure or administration. This allows network to be completely self-organizing and self-configuring. This protocol is composed of two essential parts of route discovery and route maintenance. Each node maintains a cache to store recently discovered paths. When a node needs to send a packet to another node, it first checks its entry in the cache. If it is there, then it uses that path to transmit the packet. In addition, it append the source address to the packet. If the entry does not exist in the cache, or it is expired (because of being idle for a long time period), then the sender broadcasts a route request packet to all neighbors asking for a path to the destination. The sender will be waiting till the route is discovered. During the waiting time, the sender performs other tasks such as sending, forwarding other packets in networks. As soon as route request packet reaches any of the neighboring nodes, the latter looks for the destination in its corresponding cache. If the route information to the destination is known, then the neighbor node sends back a route reply packet to the sending node; otherwise the same route request packet is broadcast.

When the route is discovered, the sender starts transmission on the discovered route. Also, an entry is created in the corresponding cache. In addition, the node maintains the entry's age information in order to decide whether the cache line is fresh or not. When any of the intermediate node receives a data packet, it first checks whether the packet are meant for itself or not. If it is meant for itself (i.e. intermediate node is the destination), the packet is received; otherwise, same packet is forwarded using path appended to the data packet. Since in Ad hoc network, any link might fail anytime. Therefore, the route maintenance process constantly monitors the status of the network. A notification is sent to the relevant nodes in case of any failure in the path. Accordingly, the nodes change the entries of their route cache.

1) DSR Advantages:

1. By using cache, the route discovery overhead is reduced.
2. Supports the multipath routing.
3. Does not require any periodic beaconing or hello message exchanges etc.

2) DSR Limitations:

1. Not effective in the large networks.
2. Packet size keeps on increasing with route length because of source routing.
3. Suffers from high latency encountered in route discovery.

Routing of Packets in DSR

The name of DSR mainly comes from the concept of source route. DSR is another reactive routing protocol for wireless network or mobile ad hoc networks. It is a simple and efficient routing protocol based on a source routing technique. Dynamic Source Routing is specifically designed for use in multi-hop wireless ad hoc networks of mobile nodes. It allows the network be completely self-configuring without infrastructure less network DSR uses source routing means source node must know the complete hop sequence to reach at destination.

In Dynamic Source Routing protocol each node maintains a route cache, where all know routes are stored. The route discovery process is initiated only when the desired route cannot be found in the route cache. Source routing uses by dynamic Source Routing means the source node determines the complete sequences of hops when each pocket should traverses. It requires the sequence of hops are included in each packet's header. A negative sequence of hops leads the routing overhead has to be carried by each packet. The main advantage here is that an intermediate nodes can learn routes from the source routes in the packets are received by them. DSR protocol has two main mechanisms are route discovery & route maintenance, in which work together to allow nodes to discover and maintain routes to arbitrary destination in the ad hoc network. Dynamic Source Routing protocol maintains a separate route maintenance procedure.

1) Route discovery phase:

Route Discovery phase divided in to two sub process namely Route Request (RREQ) and Route Reply (RREP). Route discovery are the process in which the source node wishing to send a packet to the destination node & finds a route. It is used only when the source node wants to send a packet to the destination node without knowing exact route. In route discovery phase, initially the source node broadcast 'Route Request' packet with a unique identification number. After that 'Route Request' packet is flooded throughout the network. Some of intermediate node receives the Route Request and check whether this packet has seen the RREQ or not. If the node has already seen the RREQ before in the table cache then it will discard the packet, otherwise it will respond with RREQ the source node of the packet by destination node in reverse order and store in a table cache.

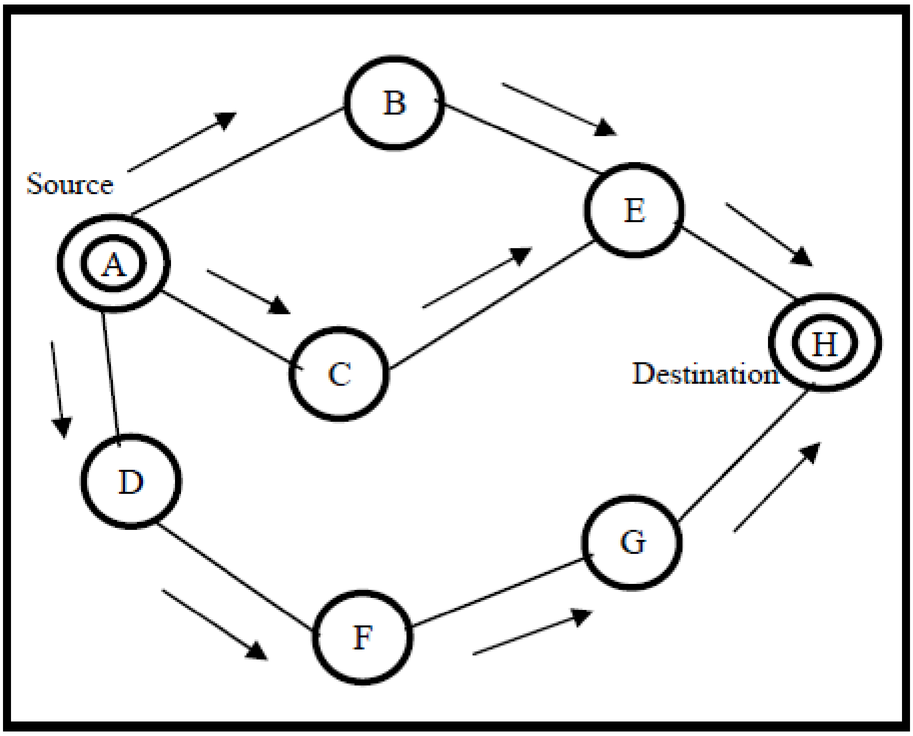


Fig 5: Route Request (RREQ) Packet in DSR

2) Route maintenance phase:

Route maintenance phase maintains route breaks. It is used for handling the route breaks from source node to the destination node during transmission. During transmission process it notice the route is broken or change in network topology. DSR protocol uses this phase for detect any other possible route towards the destination node to transmit data. If it go down then find an another alternative route to establish a connection for transmit data in communication process and after that it will invoke route discovery phase to find a new route to reach at destination node in network.

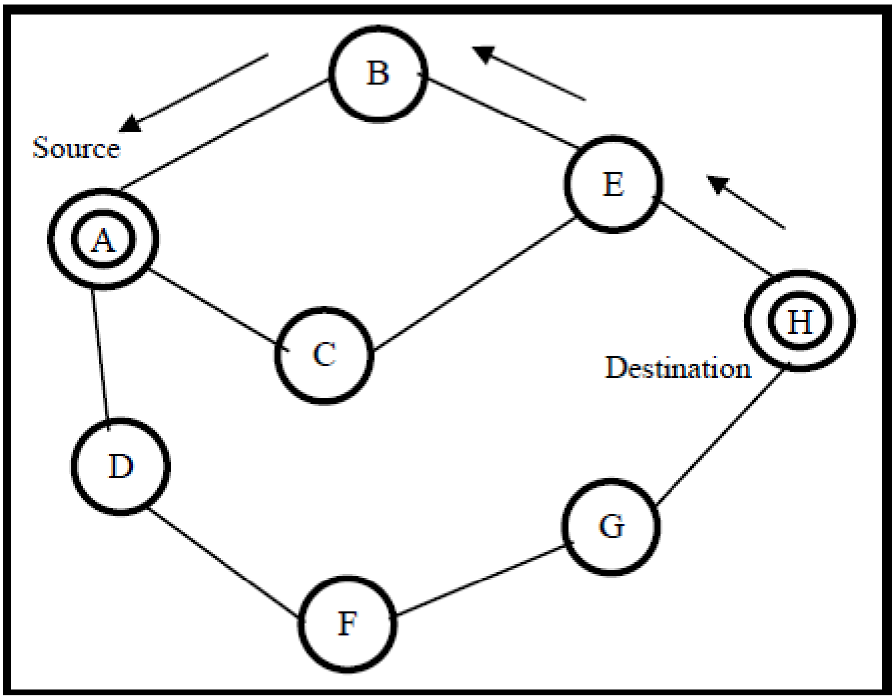


Fig 6: Route Reply (RREP) Packet in DSR

3.3 Comparative Study of DSR & AODV

This section provides a comparative analysis of routing protocols previously described. Comparison is conducted in terms of both characteristics and performance. The metrics used in the performance analysis include the following:

- Packet Delivery Ratio: this is the ratio of data packets delivered to the destinations to the total no. of packets.
- Average end-to-end Delay: This is the average amount of time taken by a packet to go from source to a destination. This includes all the possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC and the propagation and transfer times.
- Packet Loss: this is the measure of number of packets dropped by the routers.
- Routing Overhead: this is the ratio of total number of the routing packets transmitted to data packets.

A. Analysis of Characteristics

Below table summarizes the differences between the most important characteristics of the given routing protocols.

Characteristic	DSR	AODV
Loop free	Yes	Yes
Multicasting	Yes	No
Distributed	Yes	Yes
Periodic broadcast	No	Yes
QoS Support	No	No
Routes maintained in	Route cache	Route cache
Table timer	No	Yes
Reactive	Yes	Yes
Proactive	No	No

B. Analysis of Performance

- Packet delivery ratio: In case of low mobility in network, all three protocols deliver a large percentage of packets. This may be reach 100% when there is no node motion. Under high mobility simulation, Both AODV and DSR perform better than the DSDV.

- Number of nodes in the network should also be taken into consideration. DSR performance is indirectly proportional to the number of nodes in the network. The upper limit of DSR is two hundred nodes. DSDV out performs both DSR and AODV with larger number of node. On the other hand, the performance of AODV is consistently uniform.

- Average end-to-end delay: DSDV gives the highest average end-to-end delay of packets delivery as compared to both DSR and AODV.

- Packet Loss: Packet loss is defined as the difference between number of packets sent by the source and received by the sink. The routing protocol forward the packet to destination if a valid route is known; otherwise, the packet is buffered until a route is available. If the buffer is full, packets are dropped. Also, if the buffered packet exceeds a threshold value of time in the buffer without being sent, it is dropped. DSR demonstrates the least number of lost packets as compared to both AODV and DSDV. On the other hand, DSDV shows the maximum packet losses in case of varying speed. AODV has more packet losses than DSDV when the number of nodes is more than 50.

- Routing overhead: This is the ratio of the total number of the routing packets to the number of data packets as calculated at MAC layer. DSR has a lowest routing load as compared to both AODV and DSD. This is explained by following aggressive caching strategy to reply to all requests reaching the destination from a single request cycle. On the other hand, AODV suffers from a lot of routing control packets. Therefore, the routing overhead is higher than the other two protocols. DSDV routing overhead is negligible. However, it suffers from less route stability as compared to AODV.

Chapter 4

4 Proposed Framework

As the energy conservation and network lifetime is a critical issue in the MANET, we take the amount of energy left at neighbor nodes into consideration when selecting one route from multiple paths routes. To achieve this, each node needs to report its energy level to its neighbor nodes. The current energy level is normalized to the maximum battery capacity and leveled up to 100.

The multi-path selection thus takes all the next hops from available paths, and checks associated normalized remaining energy levels known to the nodes. The next hop with the highest energy level is selected. It is possible that the energy information collected at a node is not accurate. However, the promiscuous nature of wireless channel provides a node great opportunity of overhearing neighbor's information, which enables a node maintaining almost accurate record. Energy usage at a node indicates the amount of broadcasting activities. Thus it can be regarded as an indication of traffic load at the node. While selecting the next hop according to the energy levels, load balancing among the neighbors is achieved.

In this proposed scheme the main point is to calculate the load in each node in the network. Here the multipath means to execute route meaning to select the multiple path in between sender to destination and how many number of nodes in them. The Xi shows the processing capability of each node in a single path from multiple paths and how many numbers of nodes in single path and Xij calculate the capacity of all nodes which are the part of multiple routes in network. Here energy factor is measure only in the case of propose improved multipath routing by that definitely this scheme reduces energy consumption and increases energy utilization.

4.1 Implementation

Multipath Route energy base route for Load Balancing Algorithm:

4.1.1 Using AODV Routing

(1) Set N1 Mobile Node's
(2) Set S1 sender and R1 receiver Node
(3) Routing = AODV
(4) Set Initial Energy = E1 // for all the nodes energy is different value
(5) Broadcast Route
{
If (route from S1 to R1 found)
{
Check number of route;
If (route => 1) //means alternative route exist in network
{
Find (energy of each route && energy > 0)
Select only 3 routes as a best route's //shortest path among all the paths
Send the route acknowledge through all exist path
}
}
Else {route unreachable
}
}
(6) Send the data through selected path

Percentage of load from each path = $(\sum Xi / \sum Xij)*100$

Xi = Processing capability of executed route

Xij = Processing capability of all existence route

(7) Exit

4.1.2 Using DSR Routing

(1) Set N2 Mobile Node's
(2) Set S2 sender and R2 receiver Node
(3) Routing = DSR
(4) Set Initial Energy = E2 // for all node energy is different value

(5) Broadcast Route

{

If (route from S2 to R2 found)

{

Check number of route;

If (route => 1) //means alternative route exist in the network

{

Find (energy of each route && energy > 0)

Select only 3 routes as a best route //shortest path in the network

Send the route acknowledge through all exist paths

}

}

Else {route unreachable

}

}

(6) Send the data through selected path

Percentage of load from each path = $(\sum Xi / \sum Xij)*100$

Xi = Processing capability of executed route

Xij = Processing capability of all existence route

(7) Exit

4.2 Simulation Environment

To evaluate the performance of proposed E-AODV/DSR protocol, we present simulations using network simulator 2(NS2–2.35). The operation system is windows 10. If NS-2 is not supporting the windows then install 'Cygwin' to provide Linux environment in windows. The computer configuration is listed as following: CPU: @2.50GHz, Memory: 4G, Hard disc: 400G.

The simulation parameters that are used in the experiments are shown in below table.

Simulator Used	NS-2.35
Number of nodes	50
Dimension of simulated area	900m*900m
Routing Protocol	AOMDV & DSR
Simulation time	80 sec.
Traffic type (TCP & UDP)	CBR(3 pkts/s)
Packet size	512 bytes
Number of traffic connections	6
Node movement at maximum Speed	Random & 20 m/s
Transmission range	250 m
Transmission Energy	1.5 Joules
Receiving Energy	1.0 Joules
Sensor Power	.0175 Joules

A. Performance metrics

We use the four metrics to evaluate performance of the routing protocols, in which the first two metrics are most important for best effort routes and transmit protocols.

1) Packet delivery ratio: or packet throughput, is the fraction of data packets delivered to destination nodes to those sent by source nodes.

2) Average end-to-end latency: average time taken by the data packets from sources to destinations, including buffer delays during a route discovery, queuing delays at interface queues, retransmission delays at the MAC layer and propagation time.

3) Routing packet overhead**:** ratio of the number of control packets (including route request/reply/update/error packets) to the number of data packets in the network.

4) Throughput: Number of packets sends or receives in per unit of time in the network.

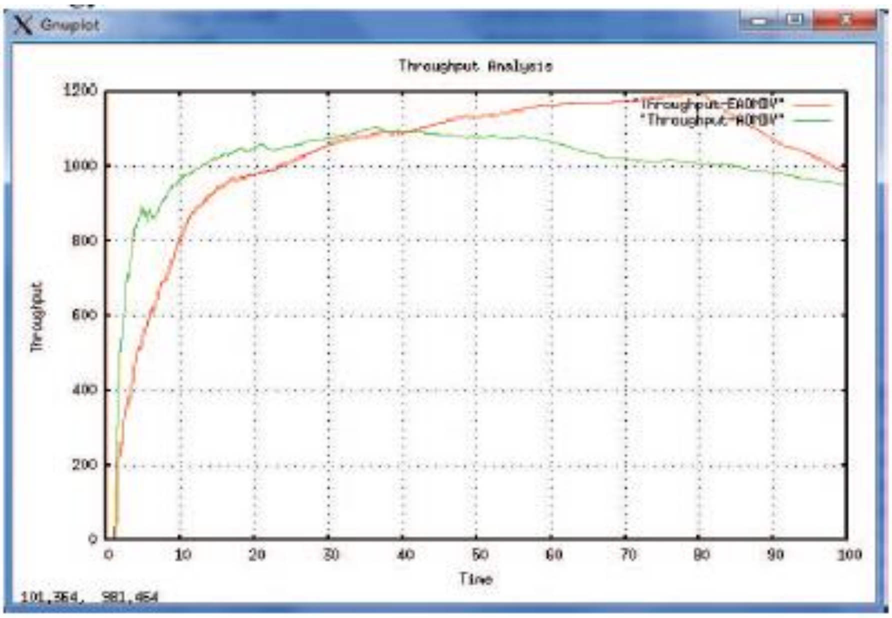
Chapter 5

5 Simulation Results

This section evaluated the results in case of previous AODV/DSR case and proposed E-AODV/DSR case. The performances of proposed scheme are better than the previous scheme.

A. Throughput Analysis in Case of AODV and EAODV

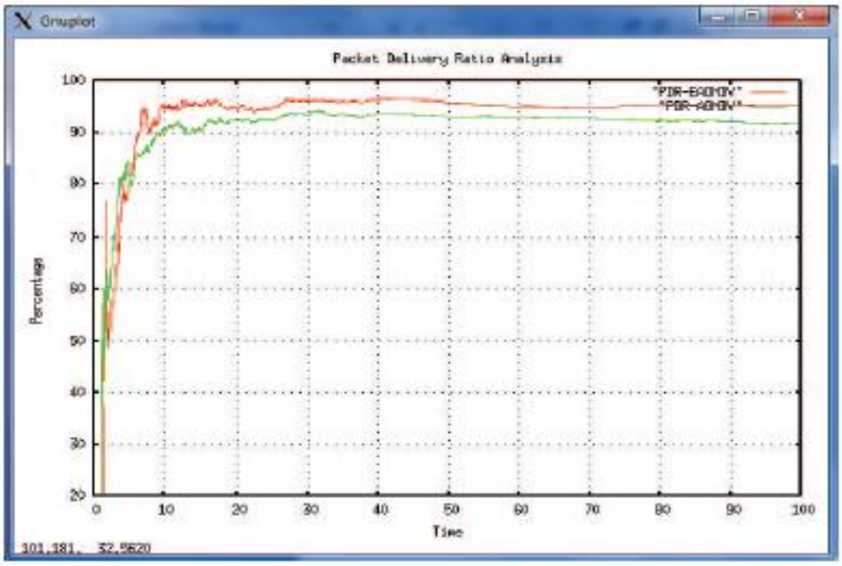
Throughput represents the number of packets send and received in per unit of time. In this graph the throughput in the case of normal AODV routing is less as compared to the proposed Energy AODV (E-AODV) routing. In this proposed E-AODV routing technique consider the node energy factor with multipath routing & improve the performance of multipath routing protocol. Here throughput of AODV is little less up to time 40 seconds but after that the throughput of proposed E-AODV routing protocol is continuously increased up to end of simulation completion. The normal multipath routing provides the alternative path but the load distribution is not takes place by that the efficiency of multipath routing is reduces and in proposed the load distribution is properly by that efficiency of multipath routing is enhanced with limited energy or limited life time factor.



Throughput Analysis

B. Packet Delivery Ratio (PDR) Analysis in Case of AODV & E-AODV

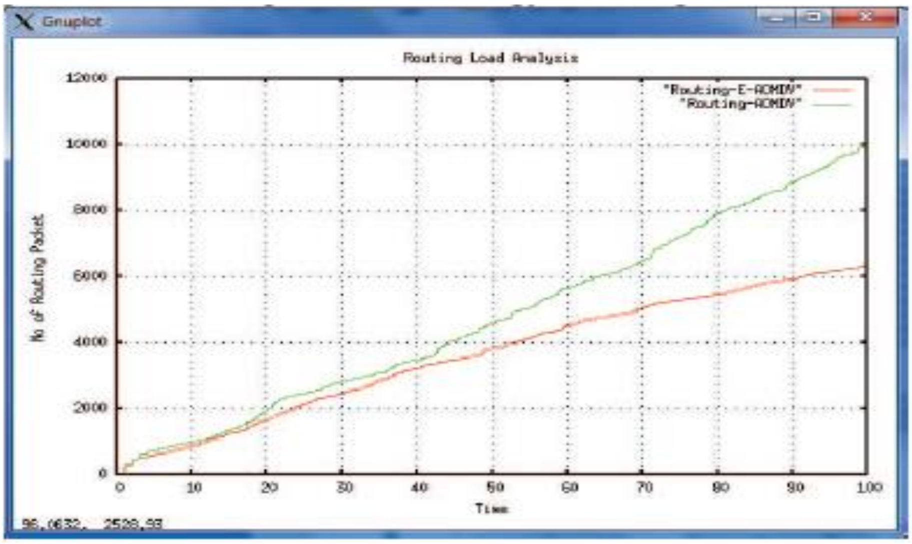
Packet Delivery Ratio (PDR) is the ratio of number of packets received and number of packets sends in network. This performance metrics is important to analyze the packet percentage successfully received in network. In this graph the performance of proposed E-AODV routing protocol is better than normal AODV routing protocol. Here in case of normal multi path routing the packet delivery fraction is about 92% but in case of proposed scheme the PDF value is about 96%. Packet transmission difference in case of the previous and the proposed scheme is almost same but the receiving in case of proposed scheme is more by that the PDF arises in case of including energy factor means life time.



PDR Analysis

C. Routing Load Analysis in the Case of AODV and EAODV

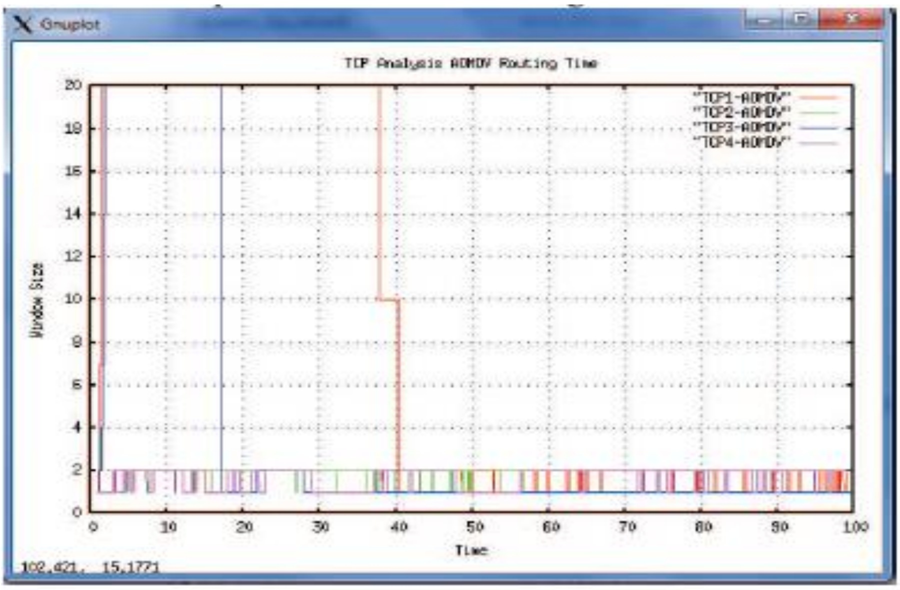
The routing load is defined in terms of number of routing packets are deliver in network to the establishment connection with receiver. The routing packets are also called the ‘Hello’ packets. In this graph routing load in case of proposed scheme is less as compare to previous scheme and the reduced value of routing load is enhances the performance of network. Here the numbers of routing packets in the case of proposed scheme are about 6200 deliver in network but in case of previous scheme about 10000 routing packets are deliver in network. The higher routing load represents the unnecessary flooding in the network and also wastage of energy but the energy factor has included in the proposed work and also improves the routing performance of AODV protocol by that the routing procedure improves and energy consumption reduced.



Routing Packet Analysis

D. TCP Analysis of AODV Routing Protocol

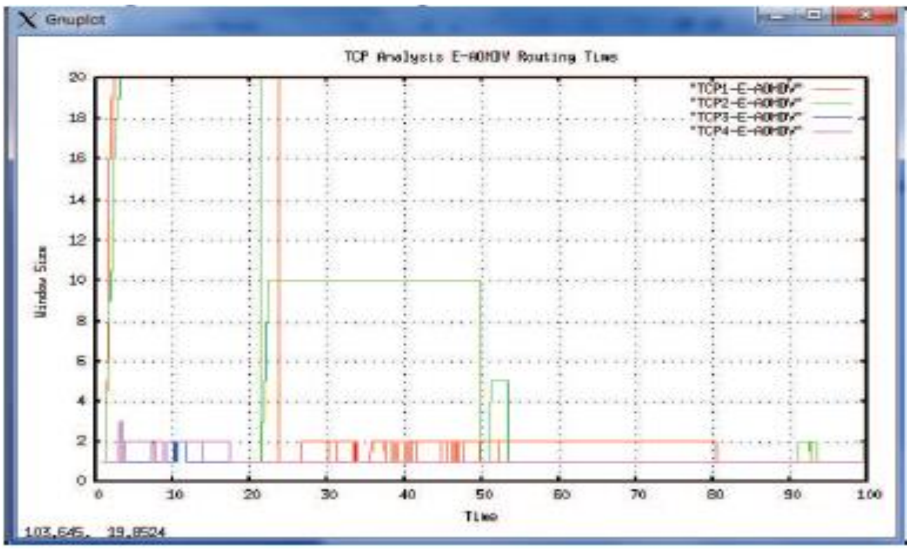
Transmission Control Protocol is the reliable protocol for communication because the confirmation of packet delivery are send by receiver to sender by that the sender is confirm about the status of data receiving. The data delivery confirmation packets called the ‘Acknowledgement’ packets. Now in the given graph the congestion window of packets or the number of packets are maximum deliver in network are of about 20. Here the four connections are created and the maximum packets are deliver by connection number TCP1 and TCP3. Rest of the connections are delivered only 2 packets in the network. It means the multipath routing provides the alternative path but not sure to provide the efficient routing.



TCP Analysis of the AODV Protocol

E. TCP Analysis EAODV Routing Time

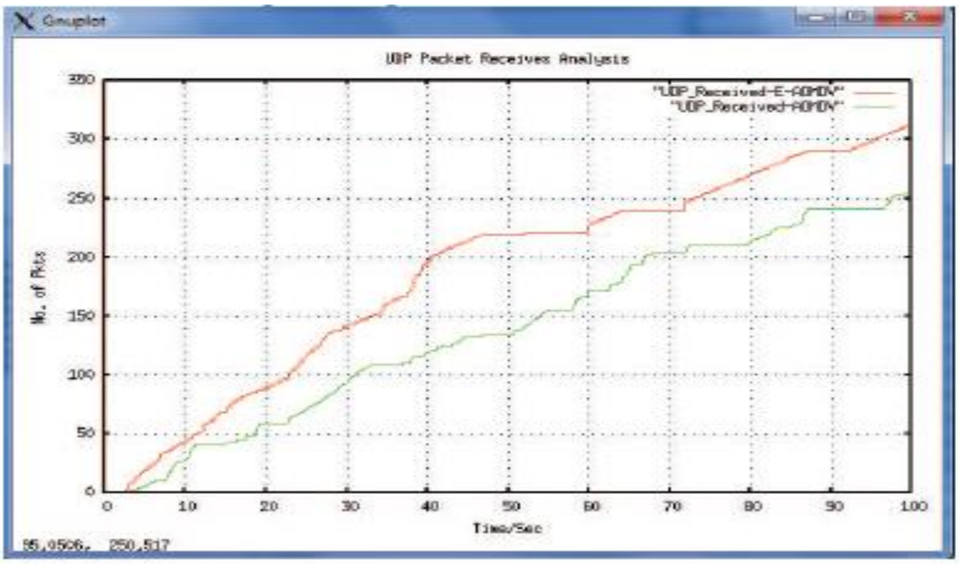
The TCP performance of Energy based E-AODV routing are better as compare to normal multipath routing. The energy factor is included here and improves the performance of multi path routing protocol to balance load and improves energy efficiency. Here we clearly visualized that the performance of connection TCP2 and TCP3 are much better and rest of them performance are almost equal to previous but the congestion window size of proposed scheme are better and deliver higher number of packets in network. The energy factor bounds the life time of network, if energy are lost then network are down but the efficient routing technique improves efficient energy consumption and network performance.



TCP Analysis of E-AODV Protocol

F. UDP Packet Receives Analysis

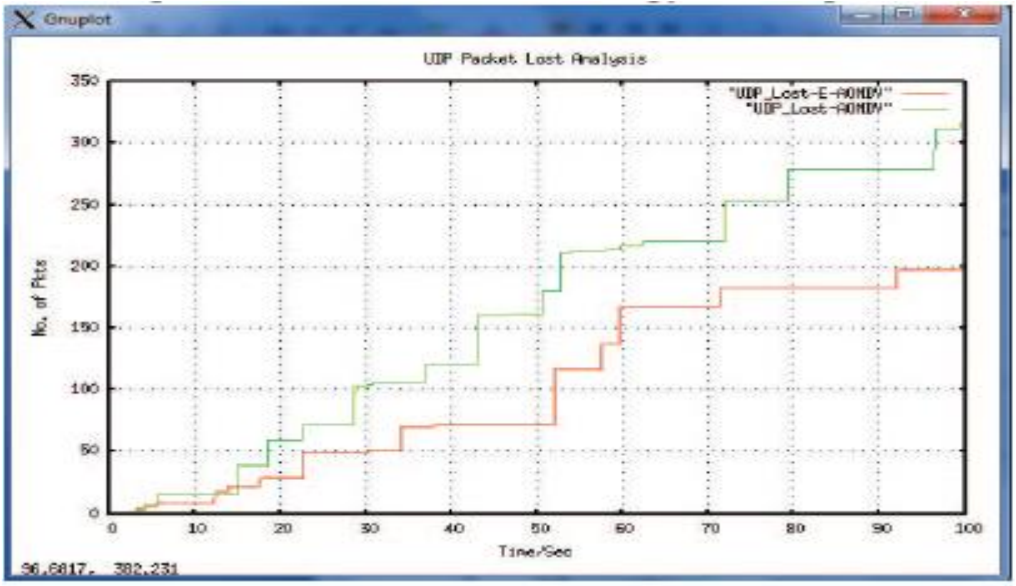
This graph represents the performance of User Datagram Protocol. The UDP protocol is not reliable for the communication because of their connection less behavior in the network. In this type of connection the confirmation from receiving are not sending by that the confirmation about successful data delivery is not sure. In this graph around 300 packets are successfully received at destination in case of proposed scheme but in the case of previous scheme only around 250 packets are successfully received at destination. It means in case of proposed scheme routing is more efficient as compare to previous.



UDP Packet Receive Analysis

G. UDP Packet Lost Analysis

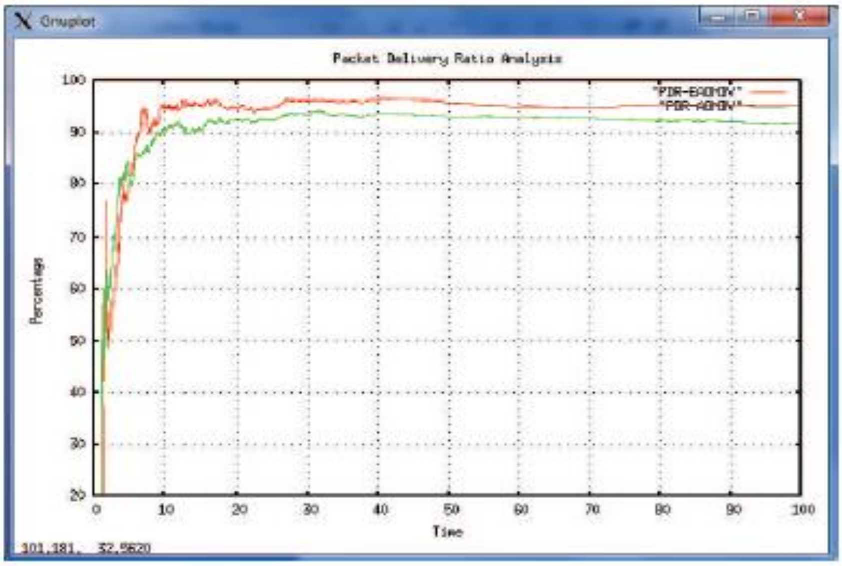
The performance of UDP packet transmission is entirely depend on network conditions. This graph represents the UDP packet loss analysis in the case of proposed E-AODV and normal AODV. The packet loss in the case of proposed scheme is only about 330 packets but in the case of previous scheme about 190 packets are deliver in network, it means the performance of AODV protocol can handle the possibility of congestion but the efficient routing has done in proposed scheme by that improve the network performance and reduces energy consumption.



UDP Packet Lost Analysis

H. Packet Delivery Ratio (PDR) Analysis in Case of DSR & E-DSR

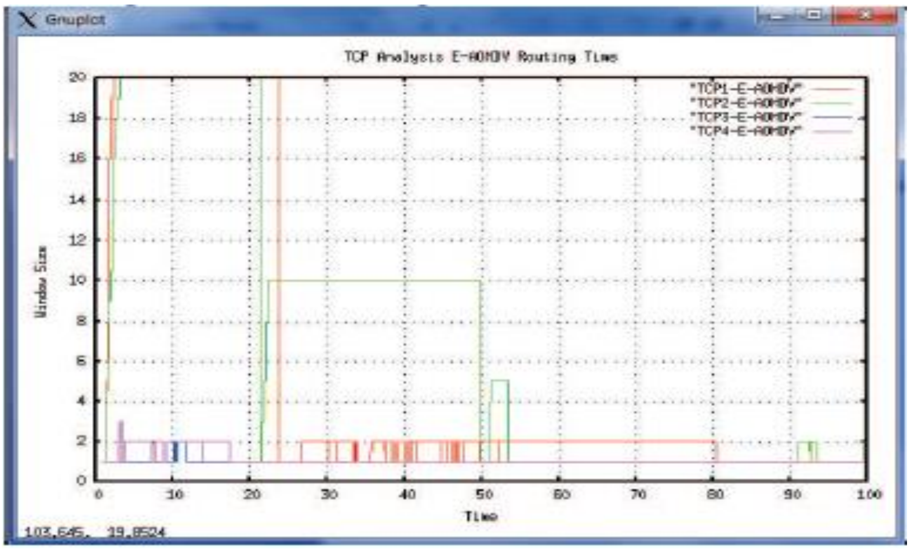
Packet Delivery Ratio is the ratio of number of packets received and number of packets sends in network. This performance metrics is important to analyze the packet percentage successfully received in network. In this graph the performance of proposed E-DSR routing protocol is better than normal DSR routing protocol. Here in case of normal multi path routing the packet delivery fraction is about 92% but in case of proposed scheme the PDF value is about 96%. Packet transmission difference in case of the previous and the proposed scheme is almost same but the receiving in case of proposed scheme is more by that the PDF arises in case of including energy factor means life time.



PDR Analysis in DSR

I. TCP Analysis E-DSR Routing Time

The TCP performance of Energy based E-DSR routing are better as compare to normal multipath routing. The energy factor is included here and improves the performance of multi path routing protocol to balance load and improves energy efficiency. Here we clearly visualized that the performance of connection TCP2 and TCP3 are much better and rest of them performance are almost equal to previous but the congestion window size of proposed scheme are better and deliver higher number of packets in network. The energy factor bounds the life time of network, if energy are lost then network are down but the efficient routing technique improves efficient energy consumption and network performance.



TCP Analysis of E-DSR Protocol

Chapter 6

6 Conclusion and Future work

Overall summery of performance of both AODV/DSR and E-AODV/DSR are representing by below table. Now the proposed scheme is definitely show the better results as compare to the previous scheme. It means the E-AODV/DSR definitely distributed the load properly including the energy factor. If the load is properly distributed then, in that case energy utilization increases and reduces energy consumption in the network. The whole summery is mentioned have improves the performance of routing with limited life time.

Summary Analysis:

PARAMETER		AODV	E-AODV
SEND	=	5809	5810
RECV	=	5317	5526
ROUTINGPKTS	=	10003	6364
PDF	=	90.64	95.12
NRL	=	1.87	1.14
No. of dropped data(packets)	=	478	273
No. of dropped data(bytes)	=	487879	278660

PARAMETER		DSR	E-DSR
SEND	=	4808	4809
RECV	=	4327	4522
ROUTINGPKTS	=	8003	4367
PDF	=	90.37	95.19
NRL	=	1.86	1.19
No. of dropped data(packets)	=	421	289
No. of dropped data(bytes)	=	426879	248761

Future work includes the developing a method to adaptively use one of the forwarding methods of the position based routing protocol based on the surrounding environments in the network topology, and dividing the network into a number of areas that varies dynamically based on the node mobility pattern.

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