ERA-AODV for MANETs to Improve Reliability in Energy Efficient Way

Thesis submitted in partial fulfillment of the requirements for the award of degree of

Master of Engineering
in
Computer Science and Engineering

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July 2017

CERTIFICATE

I hereby certify that the work which is being presented in the thesis entitled, **"ERA-AODV for MANETs to Improve Reliability in Energy Efficient Way "**, in partial fulfillment of the requirements for the award of degree of Master of Engineering in *Computer Science and Engineering* submitted in Computer Science and Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of **Dr. Shalini Batra** and **Vinay Arora** and refers other researcher's work which are duly listed in the reference section.

The matter presented in the thesis has not been submitted for award of any other degree of this or any other University.

Signature:

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This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.

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ACKNOWLEDGEMENT

No volume of words is enough to express my gratitude towards my guides, **Dr. Shalini Batra,** Associate Professor and **Vinay Arora** , Assistant Professor, Computer Science and Engineering Department, Thapar University, Patiala, who have been very concerned and have aided for all the materials essential for the preparation of this thesis report. They have helped me to explore this vast field in an organized manner and provided me with all the ideas on how to work towards a research oriented venture.

I am also thankful to **Dr. Maninder Singh**, Head of Computer Science and Engineering Department and **Dr. Ashutosh Mishra**, P.G. Coordinator, for the motivation and inspiration that triggered me for the thesis work.

I would also like to thank the staff members and my colleagues who were always there in the need of the hour and provided with all the help and facilities, which I required, for the completion of my thesis work.

Most importantly, I would like to thank my parents, friends and the almighty for showing me the right direction out of the blue, to help me stay calm in the oddest of the times and keep moving even at times when there was no hope.

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ABSTRACT

The nodes in Mobile Ad hoc Networks (MANETs) communicate with each other through wireless medium and are constantly moving. To maintain the links in a continuously changing topology is a challenge especially for longer duration of time and in such scenarios the reliability of the links becomes the prime issue. Further, the reliability must be maintained in an energy efficient way as the MANETs have energy constraints. The existing routing protocols provide the shortest path from source to destination node in terms of hop count. These do not consider the energy efficient routes neither they consider the quality of the links while deciding the route between source and destination node. The thesis presents energy efficient version of RA-AODV named as ERA-AODV which measures reliability in terms of end to end delay, bandwidth and mobility of the intermediate nodes. Since the prime factor which determines the consumption of energy of the node is the distance of communication between them, the proposed scheme takes into account adjustment of the transmission range of the mobile nodes according to residual energy; to provide improved energy efficiency. The second approach used in ERA-AODV is the use of location aided routing which reduces the number of nodes transmitting the route request packet in route discovery phase thus reducing the energy consumption. The parameters considered for performance measure include packet delivery ratio, throughput, End to End delay and remaining energy .All these parameters showed an improvement over the existing scheme.

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LIST OF ABBREVIATIONS

MANET	Mobile Ad hoc Network
AODV	Ad hoc On demand Distance Vector Routing
DSR	Dynamic Source Routing
DSDV	Destination Sequenced Distance Vector Routing
TORA	Temporally ordered Routing Algorithm
PDR	Packet Delivery Ratio
RREQ	Route Request Packet
RREP	Route Reply Packet
RERR	Route Error Packet
DAG	Directed Acyclic Graph
RA-AODV	Reliability Assured Ad hoc On demand Distance Vector Routing
ERA-AODV	Energy efficient Reliability Assured Ad hoc On demand Distance Vector Routing
NS2	Network Simulator
LAR	Location Aided Routing

CHAPTER 1
INTRODUCTION

Mobile Ad hoc networks (MANETs) is a collection of mobile nodes not including presence of any centralized control or previous foundation and can communicate with one another through radio waves. This network is self-sorting, self-restraining, and self-adaptive. The communication among nodes is set up via multi hop routing. New nodes can connect or disconnect themselves from the network whenever required. Due to the vibrant nature, the topology is frequently changing. Thus, the advancement of a safe routing convention is a basic concern. The Ad hoc network comes under the category of wireless networks. This network is a gathering of at least two devices linked by wireless correspondences and network ability. Such kind of devices can speak with an additional gadget that is quickly inside their radio signal or the one, which is outside their radio signal not depending on get to point.

A network system that involves growth of PCs and new apparatus related to it connected via associated channel for sharing information. We have two types of networks: Wired networks and Wireless Networks. Wired networks are those networks wherein PC mechanical assemblies are coupled individually via wire. This wire goes about as a mode of correspondence for transmitting data from one purpose of the network to new purpose of the network. On the other hand, a wireless network is a network where PC gadgets speak with each other without the need of any wire. The communication mode among these PC devices is wireless. At the point when PC devices want to speak with some substitute devices, the target devices must be existent in the radio signal of each other. The broadcasting and congregation of data in wireless sensor networks is done by employing the electromagnetic waves. As of late, wireless networks are receiving notable importance subsequently because of its flexibility, straightforwardness and amazingly undeviating and cost saving organization. Wireless networks are getting outstanding because of their comfort. In case of the wired networks, the users are restricted to communicate at those places where the wired connections are available. In such kind of networks, the clients have difficulty in moving freely. Whereas the wireless networks provide users opportunity

to move freely, thus giving more value to the customers. One of the mind-blowing attribute in wireless network, which makes it entrancing and extraordinary among the orthodox wired networks, is portability. This trademark provides customer the ability to transfer uninhibitedly, though being connected with the network. Wireless networks are generally simple to introduce when compared to wired networks. Wireless networks can be designed according to the requirements of the customers, as these networks are general-purpose networks, not catering to specific application. These can keep running from minimal figure of customers to generous complete establishment networks where the measure of customers is in thousands.

Mobile Ad-Hoc Networks are self-governing wireless frameworks. MANETs include mobile nodes that are allowed to move in the network. Mobile telephone, portable PC, individual computerized help, MP3 player and PC can be considered as nodes. These nodes can go about as host/switch or both all the while. They can structure self-emphatic topologies depending upon their availability with each other in the framework. These nodes are able to put together themselves and due to this interesting capacity, they can be conveyed earnestly without requiring any foundation. Various protocols used for MANETs are AODV, OLSR, and DSR and so on.

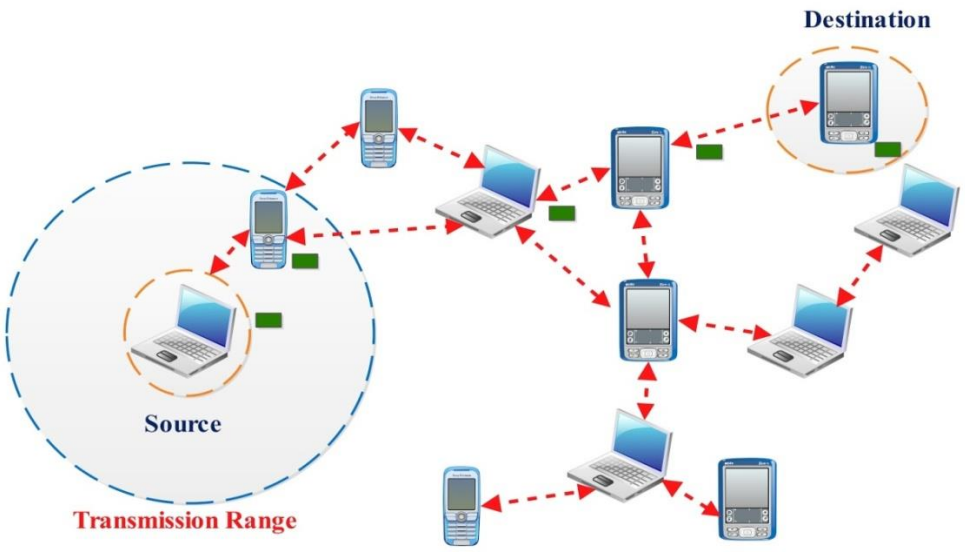

Figure 1 : MANET Overview

1.1Characteristics of MANET

MANET possesses various characteristics such as:

- **Wireless:** Nodes impart without requiring the wires as their mediums and have similar media.
- **Ad-hoc-based:** A mobile ad hoc network is a brief network organized logically in a self-confident way by amassing nodes when needed.
- **Autonomous and infrastructure-less:** MANET do not depend on settled establishment or brought together administration. Every node works in dispersed distributed mode, goes about as a free switch, and makes self-governing information.
- **Multi-hop routing:** The nodes deployed in the network require central authority. Each node goes about as a switch and advances parcels to engage information giving between convenient masses.
- **Mobility:** Every node is permitted to travel nearby though communication with different nodes [1]. The topology of that framework is dynamic in nature due to steady advancement of the taking part nodes, bringing on the intercommunication plans around nodes to adjust reliably.

1.2Design Constraints

Ad hoc wireless networks come with the acknowledged issues of wireless correspondences [1], for example, bandwidth improvement and control, their adaptability, multi-bounce nature, and the absence of settled infrastructure make different complications and design stipulations that are new to mobile ad hoc networks.

- **Infrastructure-less:** MANET do not rest upon any fabricated establishment or incorporated management. Every node works in circulated shared mode, goes about as an independent switch and makes self-ruling information.
- **Multi-bounce routing**: Every node goes about as a switch and advances packets of each other to empower information sharing among mobile hosts and no default switch is accessible.

- **Dynamically varying network topologies:** In mobile ad-hoc networks, the multi-hop network topology can change as often as possible and eccentrically resulting in course changes. This leads to sometimes the dropping of the packets in the network that are being transmitted among the nodes.
- **Dissimilarity in link and node abilities:** Every node is given at least one-radio signal, which has changing transmission and receiving abilities and work across over unique recurrence bands. Every node has another programming/equipment setup bringing about inconstancy in handling capabilities. Outlining network procedures and set of rules for this dissimilar network can be overwhelming that requires adaptable convenience to the evolving condition.
- **Energy constrained operation:** Mobile nodes contain batteries having restricted power supply; subsequently the processing force is constrained, which additionally confines the administrations in a way that each node is able to sustain the application, that network has been designed for. This transforms into a more noteworthy question in MANET as every node moves in the network, as both an end framework and a switch all the while and extra energy is compulsory to advance packets from different nodes.
- **Network scalability:** Numerous MANET arrangements consist of broad frameworks with a colossal number of flexible nodes in favor of sensor and strategic networks. Scalability is perceptive to the productive organization of these networks. It is not easy to travel towards a substantial network, which consists of nodes with controlled assets, and present numerous difficulties that are not handled in fields, for example, addressing, direction-finding, area and design administration, high limit wireless advances and so forth.

1.3Applications of MANET

Here some of the applications of MANETs are described such as:

- **Military Networks:** The latest advanced computerized military fields ask for solid and predictable correspondence in various structures. In military applications, gadgets are conveyed in moving military vehicles that can share information arbitrarily between them.

- **Sensor Networks**: Another utilization of MANETs is in the sensor networks. This network consists of various gadgets or nodes, known as sensors that are used to sense a particular approaching sign and transmit it to proper final node.
- **Automotive Applications:** Currently, the car network is in hot verbal debate. Vehicles should be engaged to communicate with one another and with moving lights forming ad-hoc networks of different sizes.
- **Emergency administrations**: Ad hoc networks are generally utilized as a part of saving operation in case any catastrophic events occur during surges, seismic tremors, and so on.

1.4 Routing in MANETs

Routing is demonstration of moving information from source to goal in a network. Different measurements choose the productivity of the course regarding number of jumps, movement, security and so on. The essential goals of routing procedures is to limit deferral, open up the network throughput, expand network lifespan, *etc*. Deciding ideal routing way and internetwork packet exchange are the two essential exercises required in routing. Portable Ad-Hoc Network is the quickest network in creation and planning from the past 20 years. Absence of the centralized authority and their vibrant nature makes the uninterrupted expansion in the field of such networks. MANETs make additional arrangements of solicitations to provide improved end-to-end correspondence. MANET routing conventions are sorted into three principle classifications, relying on the criteria when the source node has a course to the goal, as in figure 1.2

- Table driven/ Proactive
- Demand driven / Reactive
- Hybrid

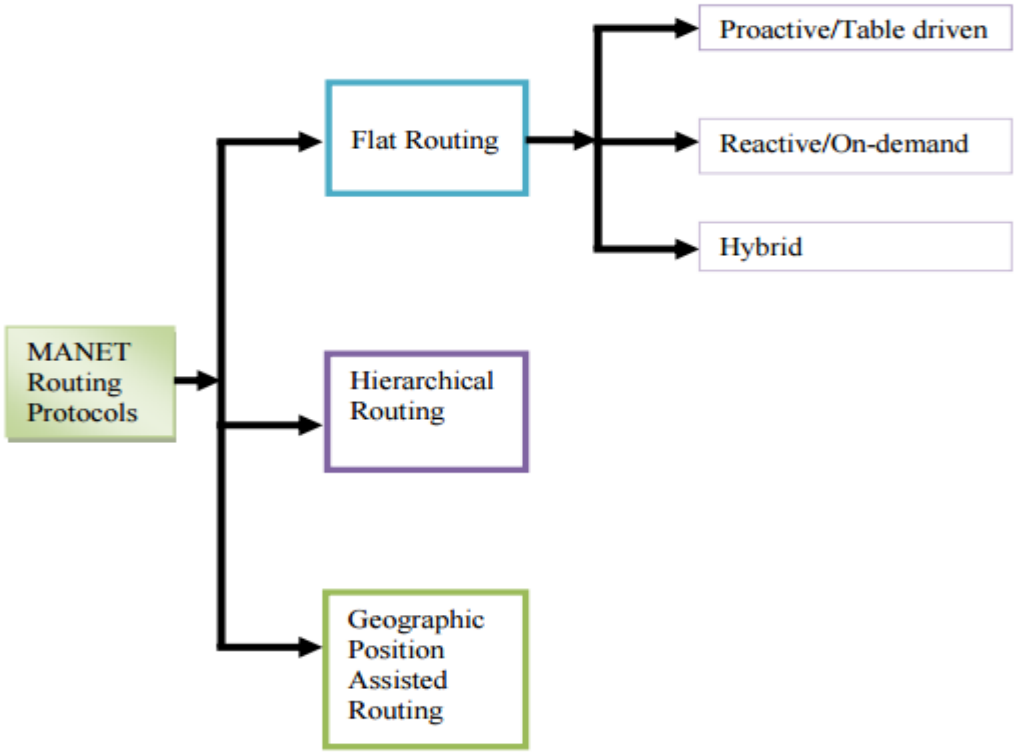

Figure 1.2 Classification of MANET routing protocols

1.4.1 Proactive Protocols

Proactive routing procedure tries to manage consistent, progressive routing information among each pair of nodes present in the network by transmitting proactively and provide path update after fixed time pauses. These are table-driven protocols because the routing information is supported in tables [1]. The proactive routing techniques intended for ad hoc networks are inferred from the conventional routing protocols. These possess a very essential characteristic that every node in the network keeps a path for each other node in the network continuously [2]. The benefit of proactive techniques is that paths are accessible as soon as they are requested. To start packet transmission and for sending data packets to destination, a source has to simply check the routing table since each node every time maintains an updated path to each other node in the network .

1.4.2Reactive Protocols

Reactive routing techniques additionally referred to as on-demand routing, use a different technique of routing as compared to proactive protocols. The need of constant maintenance of route for every node to every other node poses an overhead of the proactive protocols. The instant availability of route is the biggest benefit. These routing approaches are a take-off from regular internet routing approaches as here; the courses are found just when they are required as opposed to keeping up a steady course between all sets of network nodes. At whatever point a source node wants to send information packets to some goal, it checks its course table to make sense of if it has a course. If no course is found, a course disclosure technique is performed to find a path to the objective. From this time forward, course disclosure gets the chance to be on-demand. In an ad hoc network, nevertheless, link connectivity can alter repeatedly and control overhead is expensive [1]. The route disclosure method usually includes the system wide-ranging flooding of a demand message. To diminish overhead, the inquiry range might be decreased by different headways.

The advantage of this approach is that signalling overhead is less as compared to the proactive methodologies, mainly in systems with little to direct activity loads. At the point, when the quantity of information sessions in the system turns out to be great, then the overhead created by the path disclosure methods might even outperform to that of the pre-emptive methodologies. The downside of responsive methodologies is that when a source node requires a route, there is some limited idleness in finding the route. Conversely, with a pre-emptive method, paths are normally accessible the minute they are required. Subsequently, there is no deferral to start the information session.

1.4.3Hybrid Routing Protocols

Hybrid protocols exhibit the blend of the proactive and reactive methodologies. The network is isolated into zones, and distinctive protocols are utilized as a part of two specific methodologies. Zone Routing Protocol (ZRP) is the case of Hybrid Routing Protocol, which utilizes pre-emptive component for course foundation inside the node

neighborhood, and responsive protocols for correspondence among the area. These nearby neighborhoods are known as zones, and the convention is named for an indistinguishable reason from zone routing convention. Respective zone can have distinctive size besides every node might be inside different covering zones. The span of zone is given by sweep of distance P, where P is amount of jumps to the edge of the zone.

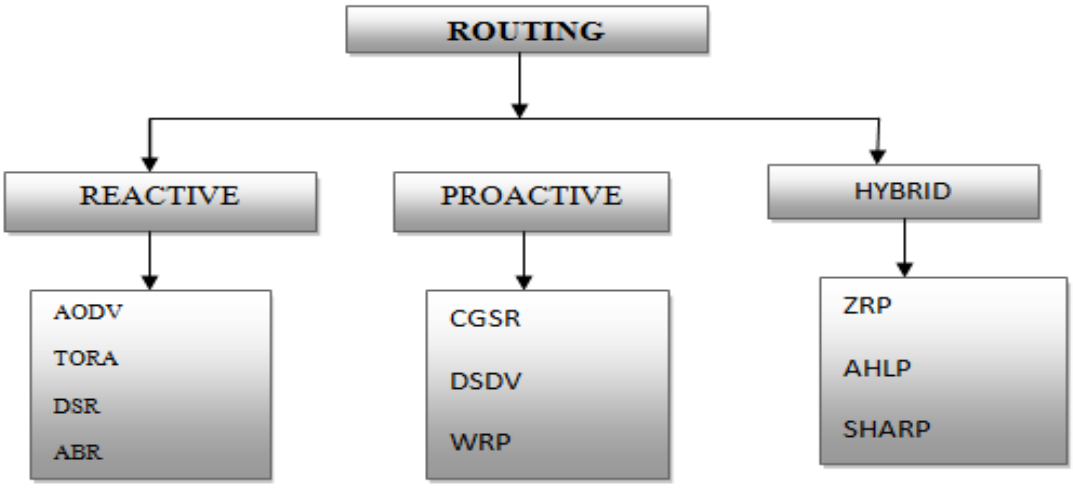

Figure 1.3 Hierarchy of routing protocol

1.5 Protocols based on Routing

Distant Vector Protocols: By utilizing the separation vector protocols, every router over the internetwork send to the neighbouring routers the data about goal that it knows how to reach. Besides the router sends two snippets of data in the first place, the router tells how far it supposes the goal is and furthermore, it tells in what heading (vector) to utilize to get to the goal. At the point when the router gets the data from others, it could then build up a table of goal addresses, remove the stale neighbouring routers, and from this table then select the most limited route to the goal. Utilizing a remove vector protocol, the router just advances the packet to the neighbouring host (or, then again goal) with the accessible smallest way in the routing table and accept that the getting router will know how to forward the packet past that point [3]. The best case for this is the routing data protocol (RIP).

Link-State Protocols: In link state protocols, a router does not give the data about the goal instead; it gives the data about the topology of the network. This ordinarily comprise of the network portions and connections that are appended to that specific router alongside the condition of the connection i.e., regardless of whether the connection is in dynamic state or the inactive state. This data is overflowed all through the network and after that, each router in the network then forms its own photo of the present condition of the considerable number of connections in the network.

Source Routing Protocols: Source routing infers that respective packet needs to pass on the whole way that packet must reach entire network. The direction-finding choice is thus finished at source. The favourable position with this method is that it is definitely not hard to refrain from routing circles. The burden is that individual packet requires minor overhead.

Flooding: Numerous routing procedures practice communication to suitable control information, i.e., direct control information from an originating node to each new node. A largely used communication is flooding. The source node guides its data to its neighbours. The neighbours hand-off it to their neighbours and so on, until the packet has accomplished complete nodes in the network. A node will simply exchange a packet one time and to guarantee this some kind of collection number can be used. This game plan number is extended for individual fresh packet a node directs.

1.6 Structure of the Thesis

The remaining part of the thesis is organized in the following order:

- **Chapter 2** gives the details of related work or literature review in the corresponding field.
- **Chapter 3** presents the problem statement and discusses the objectives to be fulfilled.
- **Chapter 4** discusses various routing algorithms, the existing algorithm is

discussed in detail ,then defines the proposed scheme and gives the implementation details.

- **Chapter 5** provides the results after the implementation of the proposed approach.
- **Chapter 6**concludes the thesis and provides future scope of the work.

CHAPTER 2

LITERATURE REVIEW

The MANETs are a collection of nodes which communicate with one another without the having any base station and do not have any predetermined topology. The nodes in MANETs are battery constrained so, due to the dynamic nature of the nodes, energy gets exhausted. Thus it is required to have energy efficient routing protocols to increase the network lifetime.

Palaniappan and Chellan (2004) proposed a steady and energy-effective routing procedure. In the planned technique, nature of administration (QoS) monitoring agents gather and calculate the connection reliability quality measurements, for example, link lapse time, probabilistic connection dependable time, link parcel blunder rate plus connection got flag quality. Furthermore, lingering battery control has been executed to preserve the energy competence in the network. Lastly, course determination likelihood is figured in view of these assessed parameters using fuzzy logic [4].

Jung *et.al*, (2005) considered energy inhibited routing procedures and load harmonizing procedures for refining MANET routing conventions and energy competence. They provide novel routing convention that utilizes adaptive load balancing method to the MANET routing with node caching improvement. Additionally, they demonstrated novel use of energy effectiveness measurements to MANET routing for energy competence assessment of the routing procedures with constrained power source [5].

Younis and Fahmy(2006)displayed a convention, HEED (Hybrid Energy-Efficient Distributed clustering), that intermittently chooses cluster heads bestowing to a mixture of the node leftover energy plus an auxiliary factor, for example, node vicinity to its neighbors or node degree. HEED ends in O(1) cycles, experiences low message overhead, besides accomplishing genuinely unchanging cluster head dissemination over the network. They demonstrated that, with proper limits on node thickness plus intra-cluster and inter-cluster broadcast ranges, HEED could asymptotically ensure availability of clustered networks.

Reproduction showed that their planned method is powerful in extending the network lifespan and supporting scalable information accumulation [6].

Rango*et.al* (2008) proposed MAC conventions for power saving in a distinct hop MANET. The crux of these conventions is grounded on rest/wake-up component, which moderates energy by permitting the host to rest for one intermission, if couple of broadcasts are involved. The planned conventions are basic and energy-proficient. Recreation demonstrated that their conventions preserved extra energy plus augmented the lifespan of a MANET. Authors offered two new systems for the OLSR routing convention, targeting to enhance its energy execution in Mobile ad-hoc Networks. Routing conventions over MANET is an imperative question besides numerous recommendations have been talked to proficiently oversee topology information, to suggest network scalability and to delay network lifespan. Nevertheless, insufficient documents reflect a pre-emptive convention (like OLSR) to deal with the energy utilization. OLSR offers the benefit of discovering a course between two nodes in the network in a brief span, because of its proactive plan, however it can use a considerable measure of assets choosing the Multi Point Relays (MPRs) and swapping Topology Control information. They suggest a change in the MPR choice system of OLSR method, considering the Readiness indication, keeping in mind the final objective to draw out the network lifespan without misfortunes of execution (as far as throughput, end-to-end postpone or overhead). Furthermore, they demonstrate that the avoidance of the energy utilization because of the overhearing can augment the lifespan of the nodes devoid of cooperating with the OLSR working by any means [7].

Abdullah *et.al* (2008)calculated the result of different ad hoc routing procedure that can be utilized for the objective framework use. There is a demonstration indicating correlation amid three ad hoc routing procedures. One is DSDV, second is DSR and third is AODV. This examination essentially focuses on the execution in light of packet delivery and standardized routing load. As indicated by researchers, in future complex simulations could be completed while investigation of the ad hoc routing procedures[8].

Kamboj and Sharma (2010) looked on the idea of nearby network system. In this route, reconfiguration based on the present position of the nodes is recommended that leads to

enhance the execution and reliability. This leads to diminished overhead, power and required data transfer capacity. These strategies guarantee great reduction in redundancy, if there should be an occurrence of connection breakages, and counteractive action of the network to resolve it. Assessment was done on different factors corresponding to packet delivery ratio and throughput [9].

Yun Ge*et.al* (2010) suggested a multipath routing protocol with node-disjoint GMR and with the cluster portability. This protocol accepts two diverse methodologies of directing intra-aggregate routing and intergroup routing to adjust in two circumstances: inside a gathering and amongst gatherings. Intra-aggregate directing strategy utilizes a proactive format. The GMR protocol results inmore energy conservation with great adaptability to the scalable MANETs [10].

Rahman and Gregory (2011)suggested another MANET directing procedure quadrant centered routing. This represents an intelligent energy matrix and energy status request messages along with packet receipt acknowledgement notification. This algorithm utilizes a wise energy framework to make a search table with the key qualities: status value and energy utilization. This algorithm additionally balance the movement consistently across four in-between nodes in some anticipated quadrant. The results showed the usage of the energy matrix and quadrant centered routing, and the transmission communication messages diminishes, decreasing information flooding, giving enhanced network productivity and progresses data transfer capacity use. To give enhanced route reliability, load adjusting additionally augments the lifetime of in-between nodes [11].

Watteyne*et.al* (2011)discussed that in vast networks, an information source cannot access the expected base station in a hop, demanding the movement to be routed by means of numerous hops. An improved decision of such routing route is acknowledged to fundamentally build the execution of believed networks. This holds mainly correct for WSNs comprising of an expansive measure of scaled down battery-controlled remote networked sensors required to work for quite a long time with no human interference. There has henceforth been a rising awareness on understanding and improving WSN routing in addition to networking procedures in modern ages, where the partial and inadequate resources have focused investigation in the direction of mainly decreasing energy ingestion, memory necessities and

complication of routing functionalities. To this, progressive protocols which require flooding in the starting stages, have relocated inside the historical period to topographical and self-sorting out facilitate centered routing arrangements [12].

Liu *et.al* (2011)referred to energy protection, a central subject of foremost significance in mixed versatile MANETs comprising of intense nodes (i.e., P-nodes) and ordinary nodes (i.e., B-nodes). By using the inborn gadget heterogeneity, the authors suggest a cross-layer composed Device Energy-Load Aware Relaying system, named DELAR, to accomplish energy protection from various aspects, together with power-aware directing, broadcast planning and power control [13].

Jeng and Jan (2011) discussed that in MANETs, batteries with constrained energy supplies typically power the cell phones. Promising methodology is topology control, which preserves energy by either decreasing communication control for every node or else safeguarding energy-effective paths for the whole network. Nevertheless, there is an exchange among the energy productivity of the nodes plus paths in a topology. In addition, it might dissipate extensive energy to keep up the topology because of node movement. The protocol lets every node to choose, either to back energy effective routing or ration its individual energy. Additionally, it can definitely shrivel the dissemination energy of reference point messages for portable nodes. Authors demonstrated that some re-establishment and modification of broadcasting radius congregates in four and five beacon intervals, correspondingly. [14].

Chen *et.al* (2012) looked at the execution of different procedures. Multipath directing depends on Fresnel zone routing (FZR), and (ENDMR) protocol. Results demonstrated that, with the proposed protocol i.e. NC-MR, packet delivery ratio besides packet loss could be evolved in many conditions [15].

Kodesia and Arya (2012) anticipated that MANET comprise of self-ruling moveable nodes, individual portable nodes communicate specifically with the nodes inside their remote range by multi hop communication. A directing procedure is compulsory to find paths amid portable nodes, keeping in mind the end goal to encourage secure and correspondence inside a MANET. Safety and energy proficiency are a few difficulties confronted in MANETs, particularly in outlining a routing protocol. Various energy proficient routing protocols are described here. The review says these protocols have diverse qualities and downsides [16].

Niranjan and Kumar, (2012)presented energy efficient strategies in wireless ad hoc networks, incorporating different issues and difficulties to give a major picture in this area. This paper addresses energy management strategies in wireless ad hoc networks, particularly in decentralized ad hoc situations. Energy efficiency is an issue of worry in wireless ad hoc networks as moveable nodes depend on batteries, which are restricted sources of energy, besides, in numerous situations, it is a difficult to energize them. In spite of the advances made in battery innovation, the lifetime of battery-powered gadgets keeps on being a key test, requiring extra research on effective outline of stages, protocols, and networks [17].

Gupta *et.al* (2013)simulated the control overhead with arbitrary mobility nodes. Simulations demonstrated that the planned area centered multipath (AOMDV) could lessen the control overhead plus increment the path lifespan than AOMDV. Just adjacent nodes are included in directing although the nodes, which are not sending, are changed to sit idle without moving state. This guarantees diminishment in energy utilization in the network. The outcomes of DREAM area centered procedure are extremely successful as contrast with ordinary AOMDV routing as well as energy centered AOMDV routing [18].

Jain *et.al* (2013)discussed a modified version of AODV and introduced EERP procedure to lessen the communication energy of a node, which is a portion of a dynamic path if subsequent bounce node is nearer. The separation can be ascertained in light of RSS (got flag quality) from next jump amid the route reply procedure. In the asking stage if the RSS is more than the threshold value at that point that node will be used for sending the packet. In answer stage, if the RSS is more, it suggests that nodes are nearer; thus less broadcast power will be needed to send information. This thus decreases battery utilization. The performance examination of anticipated procedure is investigated using Qualnet 5.0.2 network simulator and it is equated with prevailing AODV routing procedure [19].

Gouda *et.al*(2013) exhibited another Energy favorable approach in AODV, which adjusted broadcast component of preservationist AODV routing procedure. Successful transfer of RREP is critical in MANET to enhance network throughput, energy effectiveness and network [20].

Lei and Xiaoping (2013)provided an enhanced procedure with Hello system, it adequately expand the lifetime of network, enhance the effective packet rate, beat the imperfections of different algorithms that are not considering the elements of Routing Price Function [21].

Patil*et.al* (2014) have studied lifetime of the nodes in IEE. Protocol AODV has been used by picking a path with highest energy. It has been demonstrated that the measure of residual energy makes a difference to probabilistically decide an optimized path [3].

Bhatt *et.al* (2014)performed investigation of AODV routing protocol along with DSR to comprehend which one performs better in which conditions. Attention for the most part is given to some parameters such as throughput, end-to-end postponement and jitter. By varying the mobility, location, no. of nodes and MAC procedure, the simulation results have been carried. DSR performs well in these scenarios. Also, in the situation with different regions and solitary goal for CSMA and ALOHA, AODV is obviously improved. In the situation with solitary source and various goals, DSR beats [22].

Xiao *et.al* (2014)proposed a set of performance parameters in assessing network execution. Energy proficiency was analyzed at various network layers besides MAC layers, at diverse process approaches comprising idle, communicate and receive, and with diverse routing procedures comprising DSR, DSDV and AODV. The simulation values obtained were the average of five distinctive scenarios that were performed utilizing similar parameters in various mobility situations [23].

Firoze (2014)assessed the execution of routing procedure, which is Modified Energy Constraint procedure. It is driven from the AODV procedure, which depends on the neighborhood choices of middle locations to keep up the availability of the network in a way that there is tradeoff between the path length and energy consumption of the nodes [24].

Singh and Gupta (2014) described an EEAODV directing procedure, which is an upgrade in the current AODV directing procedure. The routing procedure improved the RREQ and RREP dealing with procedure to spare the energy in cell phones. At a point if the energy of a node goes below a fixed level, the node ought not to be reflected as a middle node, until no option is accessible. Simulations show that lifetime of network is expanded in EEAODV when contrasted with AODV [25].

Choukri*et.al*, (2014)defined a routing framework for a correspondence network formed by a few ad hoc moveable nodes. This framework reduces energy depletion. It isolates the network into groups. From that point, it recognizes the ideal path in terms of energy. This comprises figuring the energy needed for each accessible way and select the ideal passages. A cluster head that is chosen conferring to its place and its remaining energy by means of a clustering calculation distinguishes every group. The goal of this paper is to upgrade the quantity of living nodes by allocating every network task to suitable nodes [26].

Kumar *et.al*, (2014) presented routing procedures in relations to energy efficiency for Mobile Ad-Hoc Network (MANET). Meanwhile the nodes in MANET are moveable, the routing plus power administration get to be distinctly basic issue. Constrained power source is the greatest test of an Ad-hoc network. Consequently, in the event where one needs to build the network lifespan (time span as soon as the main hub of the network comes up short on energy) to the node lifespan, one should have an effective energy administration procedure. An Ad-hoc routing procedure overcomes such difficulties to provide the normal execution for each situation. Medium Access Control (MAC) protocols significantly affect the capacity and execution of networks. At present-day, maximum MAC procedures, utilize a similar communication power once nodes direct packets. The sending of the nodes is not symmetric in mobile ad hoc networks, which takes place along additional energy utilization and unwanted crashes [27].

Patil and Gaikwad (2015)in a survey paper have talked about different protocols, their alteration, which incorporates energy effectiveness using the significance of energy effective directing procedures. They concluded that there is no such protocol that can provide the finest execution in ad-hoc network. Execution of the procedure differs as per the variety in the network factors. Now and then, the portability of the node of the network is great, in addition to this, it is small yet energy of the node is major worry [28].

Aashkaar and Sharma (2015)proposed an improvement in an AODV procedure, which is an upgrade in the current AODV procedure. The procedure computation, which is obtained by Energy Efficient Ad Hoc Distance Vector tradition (EE-AODV), has upgraded the RREQ and RREP taking consideration of system to save the essentialness in phones. In this paper AODV, procedure is executed by using 30 nodes. The goal of this paper is to quantify the

efficiency of protocol at 30 nodes. The execution estimations used for evaluation are conveyance proportion, throughput, framework lifetime and typical energy expended. The recreation was done using NS2 [29].

Kuo*et.al*, (2016) investigated EE optimization as measured in bits per Joule for MANETs in light of the cross-layer outline paradigm. They showed that this issue as a non-arched blended integer nonlinear programming (MINLP) definition by jointly considering routing, activity scheduling, and power control. Since the non-raised MINLP issue is NP-hard largely, it is exceedingly hard to upgrade this issue. They devised a modified branch and bound (BB) procedure to productively take care of this issue. The originalities of their proposed BB procedure include upper and lower bounding plans and branching standard that are composed using the qualities of the nonconvex MINLP issue. Numerical outcomes demonstrated that proposed BB calculation plot, diminishes the optimality hole 81.98% and increases the best possible solution32.79% contrasted against reference scheme. Besides, their outcomes not only gave insights into the plan of EE amplification calculations for MANETs by employing cooperation between various layers additionally serve as execution benchmarks for distributed conventions produced for genuine applications [30].

Yadav and Salem(2016) proposed a technique for improvement of the QoS performance of load balancing method in addition to augmenting the network lifespan. The different categories of routing procedures are explained with diverse aims and intents for MANETs [31].

CHAPTER 3
PRESENT WORK

3.1 Problem Formulation

The nodes in mobile ad hoc networks are battery driven and are mobile in nature. They continue to move from one position to another and their routing is governed mostly by the reactive routing protocols such as DSR and AODV. Since the reliability of data is very important all the packets directed by the source node must reach the destination node intact otherwise it results in loss of data packets. The packets loss in the network can be due to packet collision, it may result due to presence of some malicious node in the network, the packet damage may be resulting out of link breakage etc. The existing routing protocols provide the shortest path from source to destination node in terms of hop count. They do not consider the energy efficient routes neither they consider the quality of the links while deciding the route between source and destination node [32].

The mobile nature of nodes in ad hoc networks result in link breakage between the nodes. This is one of the factors leading to packet loss. Thus, it results in decrease in the throughput. In the study done by Shoba Tyagi*et.al* in [33], the authors have worked on the reliability of the data transfer from source to destination node. For this, the paths are first arranged in decreasing order of the hop count. Then end-to-end delay and bandwidth for the shortest path is calculated. At the third step, the mobility of the intermediate nodes is considered for selection of a particular path to send information from source to destination node.

However, there are few noticeable issues in the above-described approach. First is that the authors have not considered remaining energy of the intermediate nodes to select the path. Secondly, the authors have considered hierarchical approach, for example first shortest path is checked, then end to delay, bandwidth, and then speed of the intermediate nodes. Then for the shortest path if the end-to-end delay is lesser than defined limit and bandwidth is greater than the defined limit, path is selected for data routing. However, it

can be argued that a path, which is not shortest path, can have lesser end-to-end delay and more bandwidth.

3.2 Objective

In this study our main objectives will be:

1. To study various techniques focused at reducing energy consumption of the network.
2. To propose a novel technique to reduce energy consumption and improve reliability in MANETs.
3. To implement the proposed algorithm based on AODV and analyse the performance of the proposed scheme with reliability based variant of AODV based on energy depletion, throughput, end-to-end delay and packet delivery Ratio.

3.3 Methodology

Main focus of the thesis is to improve energy efficiency of routing protocols taking into account reliability of data transfer. Methodology followed is:

- Location aided routing is used while broadcasting the packets to reduce energy consumption of the network.
- Dynamic Transmission range is applied to save the energy of nodes.
- The path selection is done by considering bandwidth , remaining energy , end to end delay and speed of intermediate nodes thus maintaining reliability.

CHAPTER 4

THE PROPOSED APPROACH

4.1Overview of AODV

AODV (Ad hoc On-demand Distance Vector) is a reactive routing procedure. It starts route disclosure and handles routes just when there is any need to discover node. AODV can deal with small, direct, and moderately high versatile rates, together with an assortment of information movement loadings. Nevertheless, it does not arrange for security. In Route Discovery there are three sorts of messages: RREQ, RREP, and RERR messages.

RREQ-at whatever point a node finds a path to the other node, it conveys the Route Request message.TTL value is conveyed by each route request packet, which expresses the quantity of jumps it must be sent for. This value is initially introduced at a predefined value at first transmission and a short time later, it continues to increase at retransmissions. Retransmissions happen when there is no answer. Each node should keep up two counters: node succession number and communicate id (Fig. 4.1).

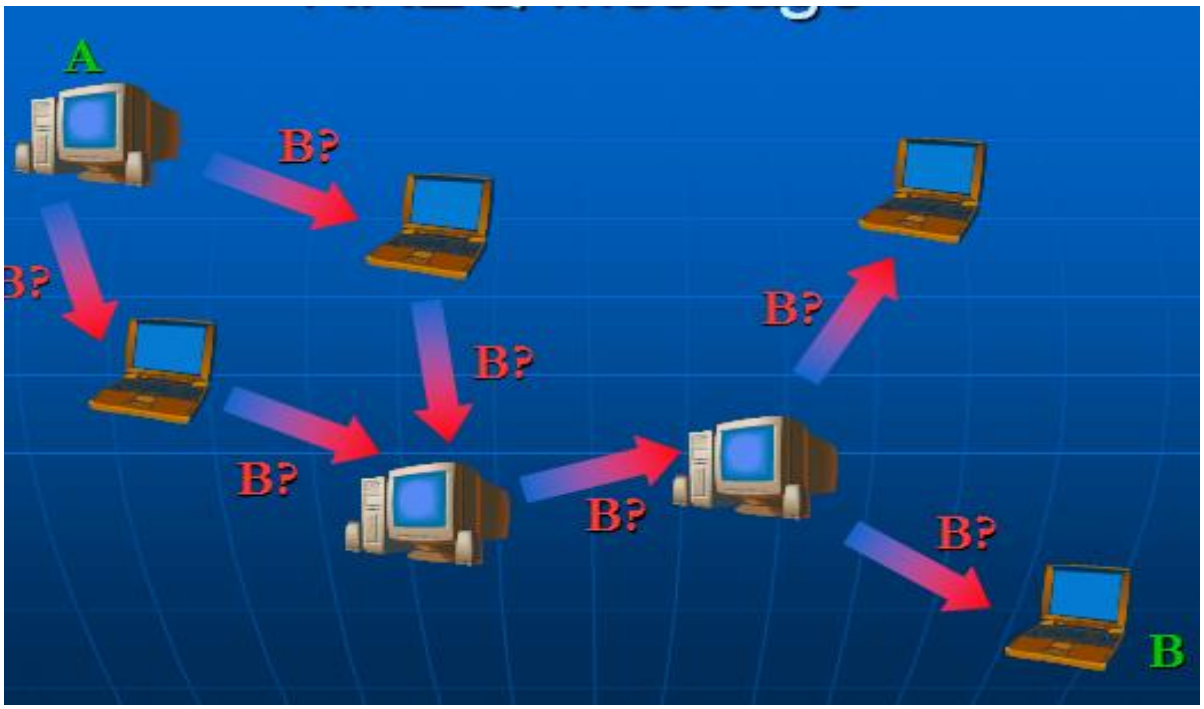

Figure 4.1 RREQ

RREP- A route reply message is unicasted to the initiator of the RREQ. The collector may be the node utilizing the address asked for or may have a legitimate path to the address asked for (Fig. 4.2).

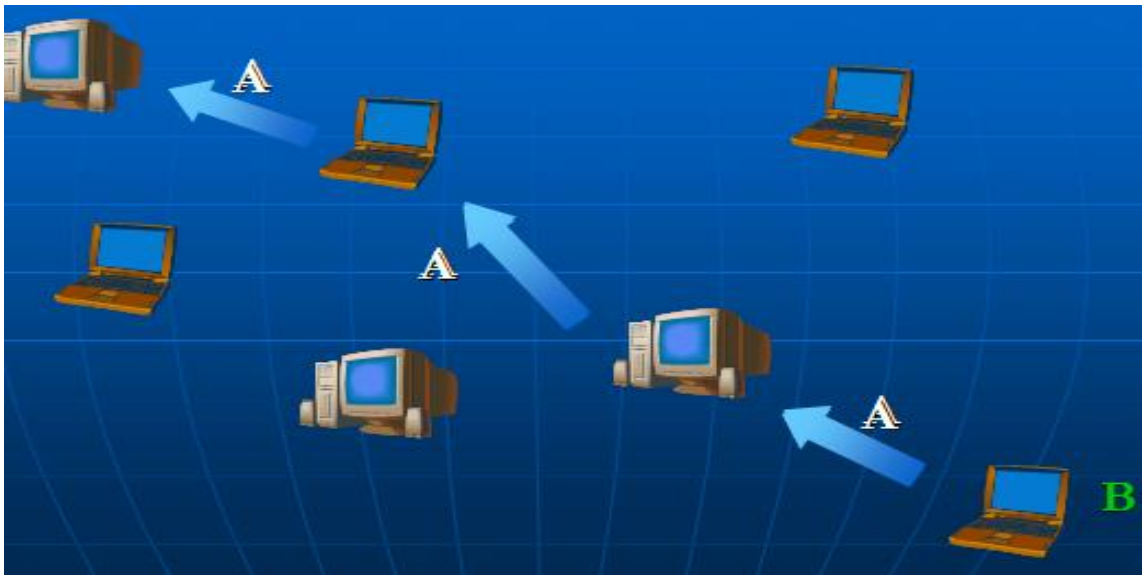

Figure 4.2 RREP

RRER-nodes continue observing the connection position of the following bounce in the dynamic paths. At a point where connection damage is recognized in the dynamic path, a RERR message is communicated to alternate nodes to inform about the damage of the connection (Fig. 4.3).

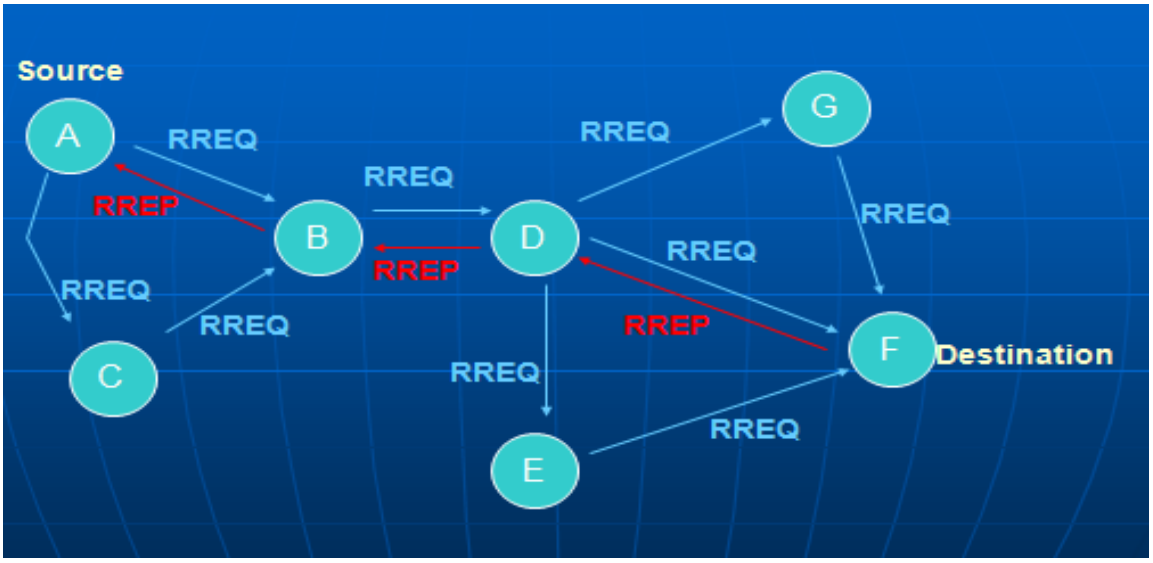

Figure 4.3Message Routing

The preeminent stride is to find the path. In path disclosure, a node communicates RREQ to entire nodes in the system until any goal is reached otherwise other node is set up with a legitimate path section for the goal to such an extent that its related grouping number is in any event as incredible as that enclosed in RREQ. At that point, RREP is directed back to the source and the found path is made accessible. Path upkeep is additionally a fundamental stride. In path preservation, once a node identify that a path to a neighbor node is not considerable, it expels the routing section and guides a RERR message to the vibrant neighbors which utilize the path. The system is rehashed at nodes that get RERR messages. AODV keeps up paths for whatever length of time that path is dynamic. A multicast tree is reserved for the existence of the multicast aggregate.

Benefits:

- On-demand path foundation with little delay.
- Connection damages in dynamic paths may be effectively dealt.
- Destination grouping numbers are utilized to locate the most recent route to the goal.

Disadvantages:

- Intermediate routes can prompt to conflicting routes whether the source succession number is older.
- Many RERR packets because of single RREQ packet can cause serious control transparency.
- Periodic beaconing prompts to transfer speed utilization.

4.2 Overview of DSR protocol

DSR, which is a reactive routing protocol, checks the ideal route just at the time when packet should be sent. The procedure to discover a way is quite recently executed at the time when the way is required by a node, which prompts to On-Demand Routing.

The DSR protocol is made out of two principle systems that coordinate to allow revelation and support of paths in MANET:

Route Discovery: At a time when a node S wishes to send a packet to the target node D [34], it gets a path to D and this process is known as Route Discovery. It is utilized just when Source needs to send a packet to Destination and has no data of a path to it.

Route Maintenance: The current routes are no longer usable when there is an adjustment in the network topology. In such a situation, the source S can utilize an option route to the goal D, or conjure Route Discovery. This is called Route Maintenance.

In DSR, the initiator decides the complete way from the initiator to the final node and then stores the areas of the middle of the road nodes of the route in the packets. As opposed to the reactive protocols ABR, protocol DSR is guide less which implies that there is no welcome messages utilized among the nodes to advise their nearby nodes about their nearness. DSR was created for MANETs with a little measurement near 5 and 10 jumps and the nodes ought to just move around at a direct speed. DSR depends on the Link-State Algorithms; every node is capable to spare the ideal path to a goal. Any change seen in the network topology is communicated to the entire network by flooding.

4.3 Overview of DSDV

DSDV, which is a proactive routing protocol, created on the groundwork of Bellman-Ford routing protocol with couple of variations. In this procedure, every portable node keeps up a routing table. Each of the routing table contains the rundown of every single accessible goal and the quantity of bounces to each. An arrangement number began by goal node is labeled with each table passage. Periodic redesigning of the routing tables adds to keep up the topology data of the network. On the off chance that there is any new noteworthy change for the routing data, the overhauls are communicated rapidly. Thus, the routing data upgrades may either be intermittent otherwise occasionally determined. This protocol desires every versatile node in the network to advance its personal routing table to its present nearby nodes. The advancement is completed either by communicating or else by multicasting. Nearby nodes can think about some alteration that has happened in the network because of the developments of nodes by the method for advancement.

The routing redesigns can be directed via two methods-'full dump' and 'incremental'. If there should be an occurrence of full dump then the whole routing table is transmitted to the nearby nodes while in the event of incremental overhaul, just the passages that involve changes are sent. The full dump is transmitted for the most part occasionally when no node development happens. The incremental upgrades could be more suitable when the network is moderately steady so additional movement could be kept away from. However, when the development of nodes are noticeably increasing, the sizes of the incremental upgrades turn out to be substantial. Thus, in that case, full dump can be utilized. Each of the route upgrade packets likewise has a succession number relegated by the transmitter. For upgrading the routing data in a node, the overhaul packet with the most noteworthy arrangement number is utilized as the most astounding number which signifies the packet is being sent over the latest fresh path. Every node holds up to fixed time interval to send the promotion information to its nearby nodes so that the most recent data with improved path to a goal could be educated to the neighbors.

4.4 Temporally-Ordered Routing Algorithm (TORA)

TORA is called interface inversion protocol. It is compelling in fathoming the current confinements in versatile ad-hoc networks. Because of mobility of nodes, clog is real issue in MANETs. In these networks, traditional algorithms that make shortest path between the nodes cannot work appropriately. It is hard to refresh the routing tables of vibrant nodes. In TORA, every node transmits an inquiry packet besides the beneficiaries transmit a refresh packet. It bolsters the circle free, numerous route offices. Utilizing "Level" a nonhierarchical routing algorithm, it likewise gives better adaptability. To find a route, it utilizes the DAG and furthermore utilizes an arrangement of completely requested statures at all circumstances. In this approach, there might be just single path over which data is being sent to the required node. Consequently, it is unidirectional; there is zero chance to fall in unbounded circle. It performs four essential operations route creation, route support, route cancellation and enhancing routes.

4.4.1 Properties of TORA

Disseminated routing - every router needs to keep up data about the adjacent routers as it were.

Circle free routing- because of utilizing the DAG, data dependably flows in one course instead of numerous routes. This process limits the communication overhead, which also limits the usage of the channel during the data transmission. It gives the support of connection status detecting and neighbor delivery, solid inorder control packet delivery and security confirmation.

4.5 Label Distance Routing (LDR)

This protocol is an on-request routing protocol. If there should be an occurrence of on-request routing protocols, Count to Infinity issue is a critical issue. This issue happens when the routing falls in boundless circle because of disappointment of connection or nonappearance of goal node. To maintain a strategic distance from this issue it utilizes goal arrangement numbers. It utilizes this arrangement numbers such that goal nodes need to answer less RREQs .Two parameters are utilized to perform operations: goal arrangement numbers and plausible separation. Goal grouping number and plausible separation (the lowest known separation from a router to a specific goal) are utilized to reset the separation to a goal node, which allows a node to acknowledge a next bounce to report a remove bigger than the node's plausible separation. A node holds littlest separation to a goal node for its present grouping number for discovering the goal. In LDR, requesting of nodes has happened in view of the label of each goal, where the label contains esteem achievable separation. Another critical property of LDR is that it guarantees dependably circle free properties. To overcome the restrictions of arrangement numbers, it utilizes remove label. It utilizes two novel parameters: practical separation of DUAL and grouping number like AODV.

4.5.1 Basic working rule of LDR

To play out the fundamental operations, there are three control packets (1) RREQ (2) RREP and (3) RERR. It accepts that all connections are genuine with unit cost and discovers least bounce through the network by utilizing the accessible data. To play out the essential operations it utilizes two terms: advertisement and sales. Here, advertisement is utilized to recognize the bit of a packet that can appropriately achieve the goal and sales is used for distinguishing the segment of a packet having the data for a

destination. RREQ is the tuple, which is looking for the path to the goal with identifier destination, which is utilized for grouping quantities of source and goal separately. To organize the flooding it utilizes source-particular one of a kind identifier. RREP tuples stay lifetime is in milliseconds for the route to destination.

Route Process: LDR protocol finds routing way through a network utilizing the sales as well as advertisements. It generally guarantees circle opportunity condition utilizing labels, which follows a strict fractional request. These labels originated from positive whole numbers, which frame a meager with label set. This protocol is constantly re-labeling the segment of the chart so it can adjust with varying node positions. Key impediment is to create re-label of nodes in powerfully evolving topologies. To handle such sort of issue, LDR utilizes a re-label sub-chart as a successor-way reset that gives an achievable advertisement.

4.6 Existing RA-AODV

In this paper [33]the authors have proposed an algorithm on which reliability assured AODV (RA-AODV) is based . The algorithm is based on forwarding RREQ (Route Packets) control packets to determine all the possible routes from source (S) to destination (D) . After that, selected paths are arranged in the order of increasing hop counts. Choose the 1st shortest path to check whether it fulfills the QoS requirements of minimum allowed EED first and then Bandwidth in a Sequential approach manner. The intermediate node of the chosen route should move with slow speed otherwise officiate some neighboring node to work on its behalf. Following is the algorithm presented briefly for RA-AODV as an extension to AODV routing protocol:

AODV (S, D, Data, EED, Bandwidth)*// Route Discovery Phase*

{

Source S initiates the RREQ packet and search neighboring nodes in the direction of destination D;

If (next-hop! =D && Loop free)

{

Source S broadcast the RREQ packet to all the neighboring nodes and continues till destination is not explored.

}

Else

{

Destination D is reached

}

In the cache of the direct/intermediate nodes, retrieve the routes from route caches. Add these routes in the route record and then generate the route reply packets in that order.

// Route Reply Phase

If the route/s is/are found

{

Maintain a list of all discovered routes as LR.

RA-AODV (LR, EED, BW, Hop count);

} ***// AODV provisioning Reliability Phase being called here***

Else

{

Destination node D not reachable may be due to high mobility of nodes and network partitioning;

}

RA-AODV (LR, EED,BW, Hop count);

}

RA-AODV (LR, EED,BW, Hop count)

{

// AODV provisioning Reliability Phase

1. Arrange the routes discovered in the order of length or hop count.

2. Pick the first shortest path R*i* as a route.

3. Calculate EED*route* and Bandwidth of the chosen path R*i.*

If ((EED*route*<=minimum Allowed Delay for the application)&&(BW>=min BW for the application))

{

If (intermediate_node_speed is slow && with in transmission range)

{

Select the route for data transmission between Source and Destination pair;

}

Else

If (speed is high and node moves out of transmission range)

{

Node has to adjust its neighboring node in its absence , so that adjusted node take over the responsibility of high speed mobile node. New data packets are now routed through this new node as a part of the route.

}

Else

{

Pick second route from the LR and go to 1 and continue the process till the data packets are actually delivered.

}

After the all data packets are sent then route is released so that it can be used for some other source destination pair. ***// route is purged after done with transmission***

}

4.7Proposed Scheme

1. The energy in the network is normally consumed during the broadcasting and data forwarding procedure. The source node forwards the RREQ packet to the neighbours to find a path to destination node when destination is not found in its routing table.
2. The existing scheme does not take into consideration energy depletion of the network so it trails normal broadcasting procedure where any node would forward RREQ packet to all the neighbouring nodes.
3. Whilst on the other hand, the proposed work aims at minimizing the energy consumption, so the scheme would make use of Location Aided Routing. According to this concept, the nodes in mobile ad hoc networks are assumed equipped with GPS and the source node has the knowledge of coordinates of destination node.
4. While forwarding the RREQ packet the node will forward the information about location coordinates of destination to the neighbour node.
5. Upon receiving the destination coordinates nodes can make a choice as to if they are located in quadrant towards destination or not. If any node is located outside the quadrant, it will not forward the RREQ packet.
6. Another thing the proposed scheme takes into account is the transmission range of the node. It is well known if any node forwards the data over a longer distance, it would consume more energy.
7. Therefore, in the proposed scheme, if any node has less energy remaining then it would transmit the packet over a lesser distance. The transmission range would be adjusted according to remaining energy of the nodes.
8. When the destination node receives the RREQ packet, the destination node will sort out the paths according to:
    a. Highest remaining energy, least hop count, least delay and supreme bandwidth and least speed of the intermediate nodes.
9. The destination will reply to source node via best optimized path through which the source node will send the data.

The algorithm for the broadcasting of the Route Request packets, which includes changing the transmission range according to the residual energy of the nodes, has been described below:

{

Source S starts forwarding the RREQ packets to the neighboring nodes.

If (Destination node exists in the Routing Table)

{

Execute Route Reply phase

}

Else

{

Check the residual energy

Adjust the Transmission Range accordingly and find neighbors

Put the neighbors in the set – N

If (Neighbor satisfies LAR Condition)

{

Forward the RREQ packet until destination is found

}

Else

{

Do not forward the RREQ packet

}

} }

4.8 Implementation

The implementation is performed in NS2.35 whose snapshots are below.

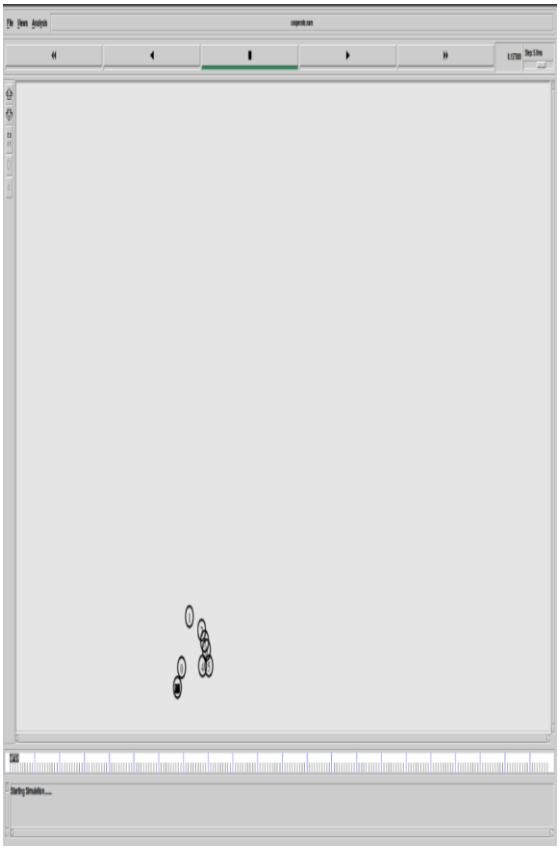

Figure 4.4: Network deployment starts

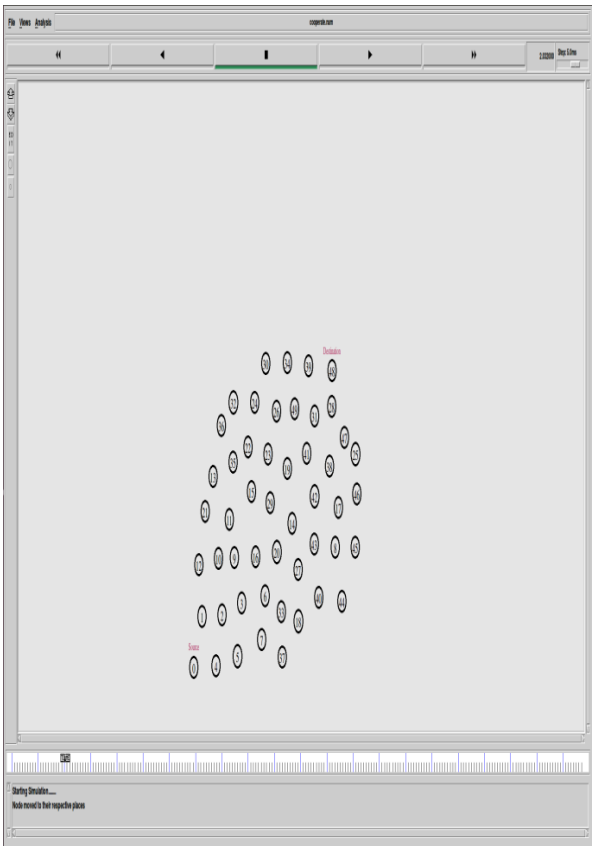

Figure 4.5: network fully deployed

First step is the creation of the network. The nodes are being deployed to their individual places in the snapshot 4.4. Figure 4.5 shows the completely deployed network.The total number of the nodes deployed are 50. The node 0 acts as the source node and node 48 acts as the destination node.

Next step is to discover a path from source to destination node in the network. The source node starts broadcasting process. In this process, the source node looks for neighbors in its communication range. Then it forwards RREQ packet to them asking for a path to destination. In the proposed work, every node along with the RREQ packet sends coordinates of the destination node. The destination node's coordinates are used to select only those nodes, which are lying in the quadrant towards the destination. In the figure 4.6, the source node sends RREQ packet to the neighboring nodes. The nodes are shown in the blue color and are referred to as one-hop nodes.

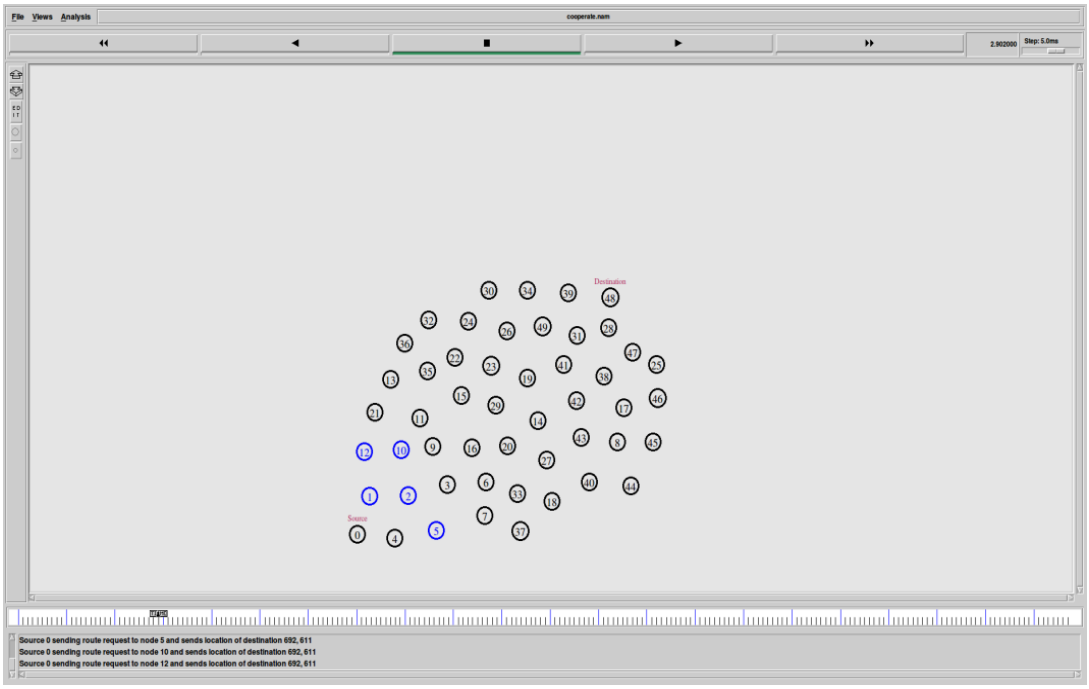

Figure 2.6:RREQ packets sent to one-hop nodes

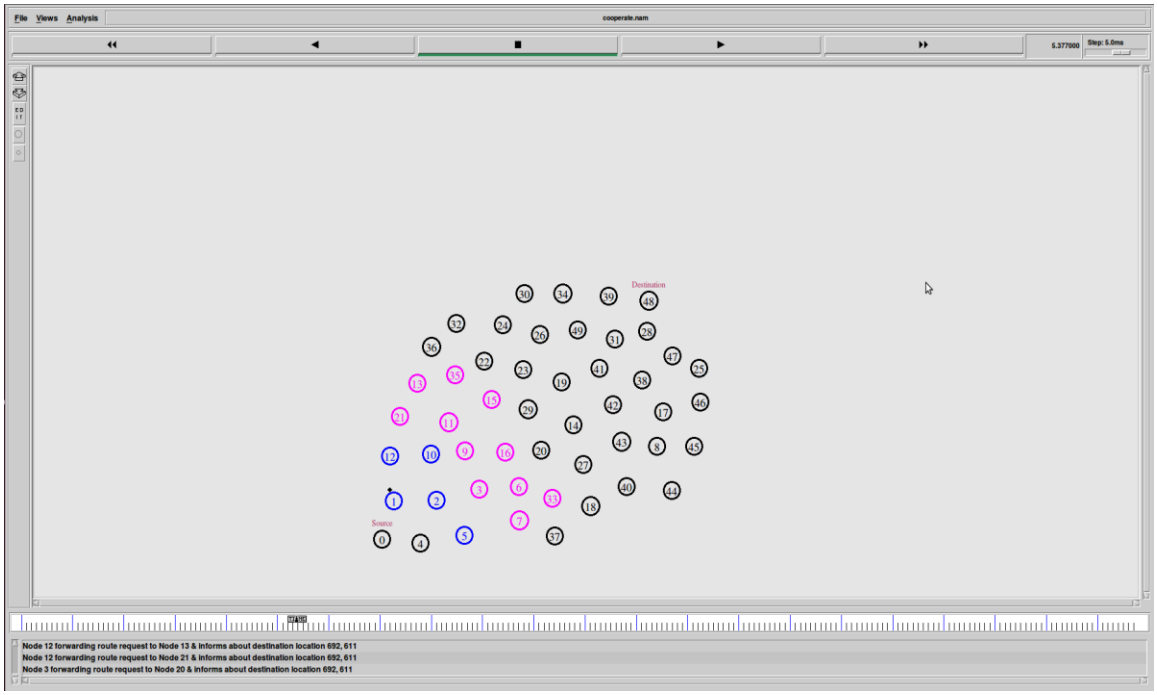

Figure 4.7: RREQ packets sent to two hop nodes

The one hop nodes receive the destination coordinates from the source node. If they have route to destination they will direct Route Reply packet to the source node, else they will find neighbors in the communication range which are lying in the quadrant towards the destination node. Then they forward the RREQ packet to them. These nodes, which receive the packet, are shown in the pink color and are two hop nodes(figure 4.7).

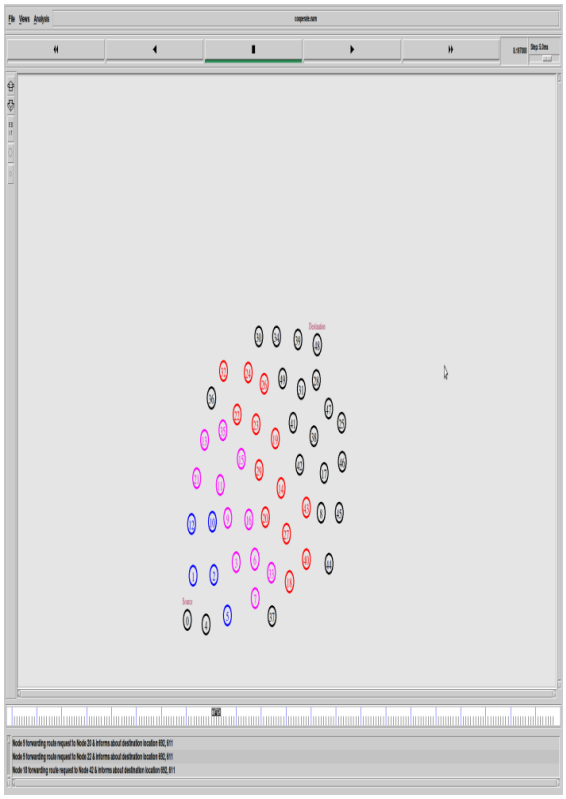

Figure 4.8: RREQ sent to three hop nodes

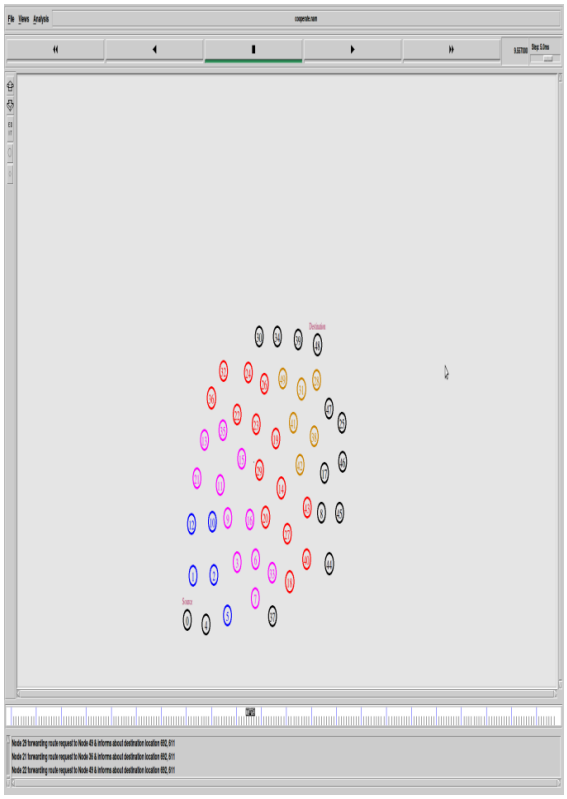

Figure 4.9: RREQ sent to four hop nodes

The two hop nodes follow the similar procedure to advance the RREQ packet to the three hop nodes shown in the red color in fig 4.8. It can be seen that nodes 4, 36 and 37 have not received any RREQ packet because these might be lying outside the quadrant of the destination node.

The three hop red colored nodes forward the RREQ packet to the four hop brown colored nodes fig 4.9. In this whole process of broadcasting, the concept of the flexible or adjustable transmission range has been used. If any node has residual energy less, then it

will not forward the packets to the neighbors lying in the full communication range of 250 meters. (250 meters is by default communication range in NS2). Therefore, the nodes with lesser energies will shorten their communication range and advance the RREQ packet to the corresponding neighbors.

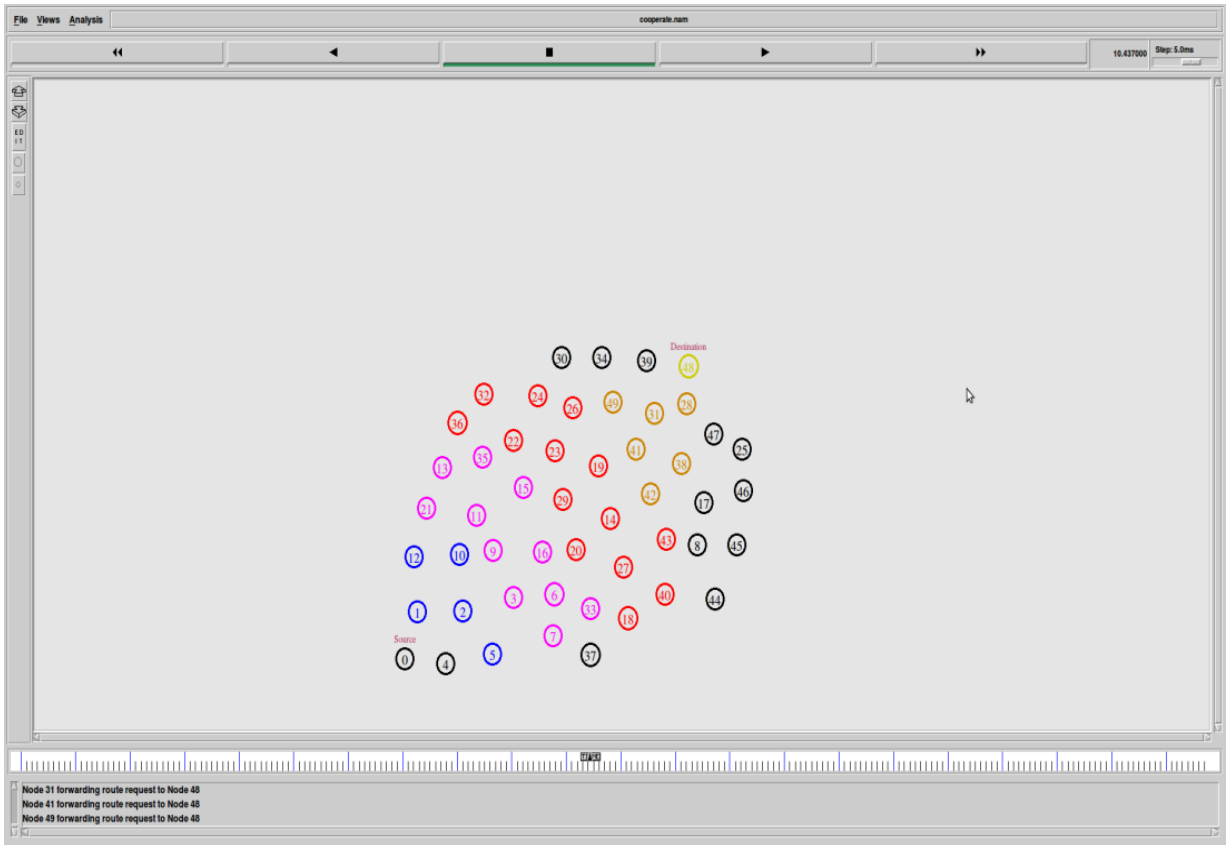

Figure 4.10: Destination receives RREQ packet at the fifth hop

The destination node receives RREQ packet at the fifth hop (fig 4.10). However, it can be noticed that the nodes in the black color did not received RREQ packets. Thus, the amount of the broadcasting gets reduced in the network.

Figure 4.11 showing the completion of the broadcasting process in the existing scheme. Here every node in the network is involved in the transmission or reception of the RREQ packet. Thus when compared to the former figure, it is evident the broadcasting has be reduced in the proposed scheme.

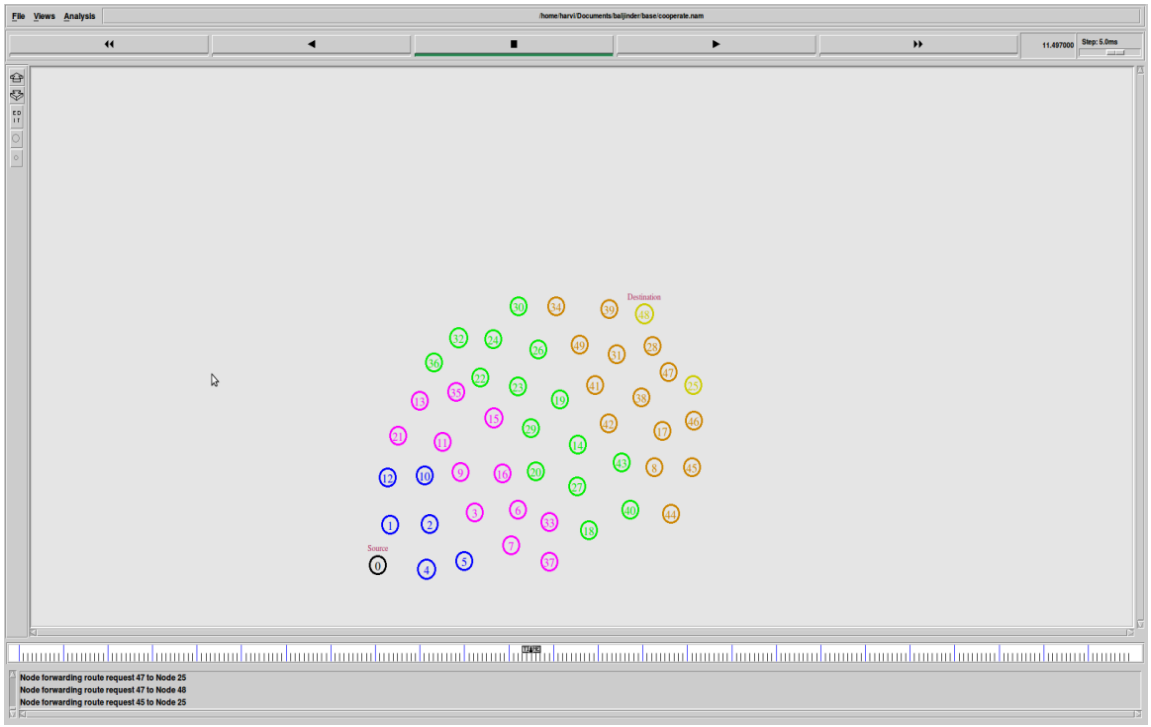

Figure 4.11: Broadcasting process in existing scheme

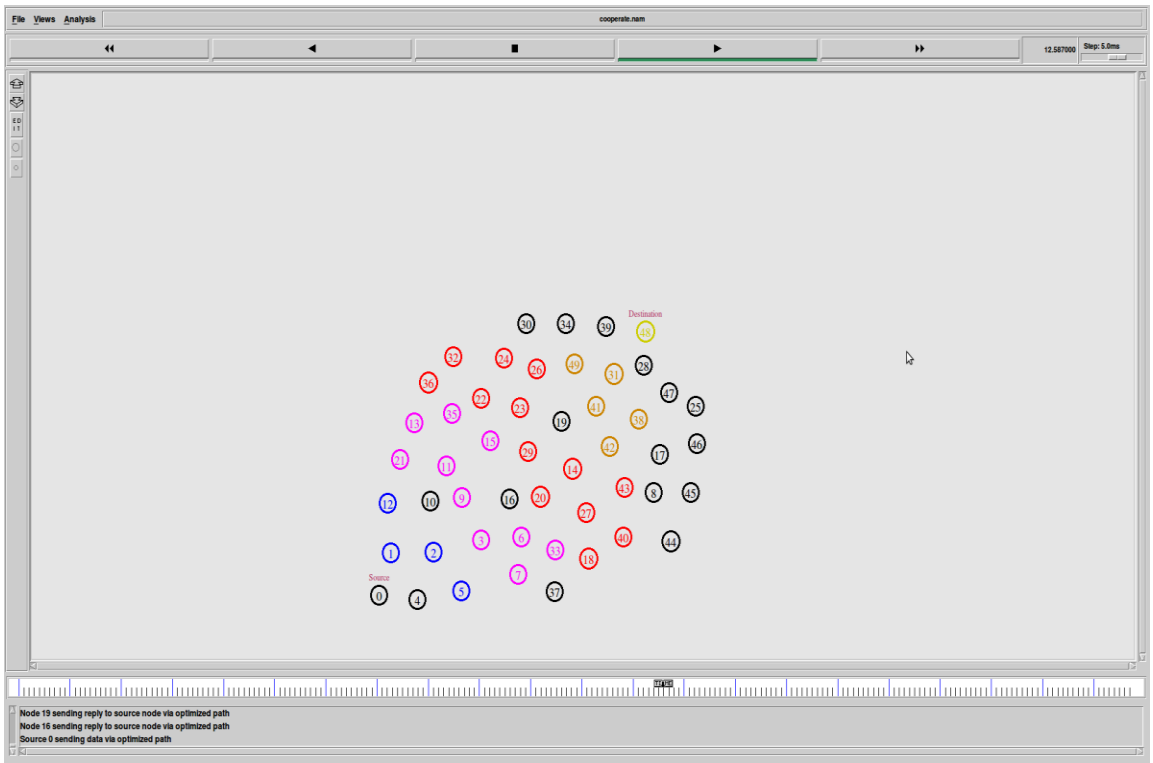

Figure 4.12: path selection from source to destination in proposed scheme

This figure 4.12 shows the selection of the pathway from source to destination node, the pathway selected is 0-> 10-> 16-> 19-> 28-> 48.

This path has been selected considering the reliability of the network. The parameters considered while selecting the path are:

Highest remaining energy, least hop count, least delay and supreme bandwidth and least speed of the intermediate nodes.

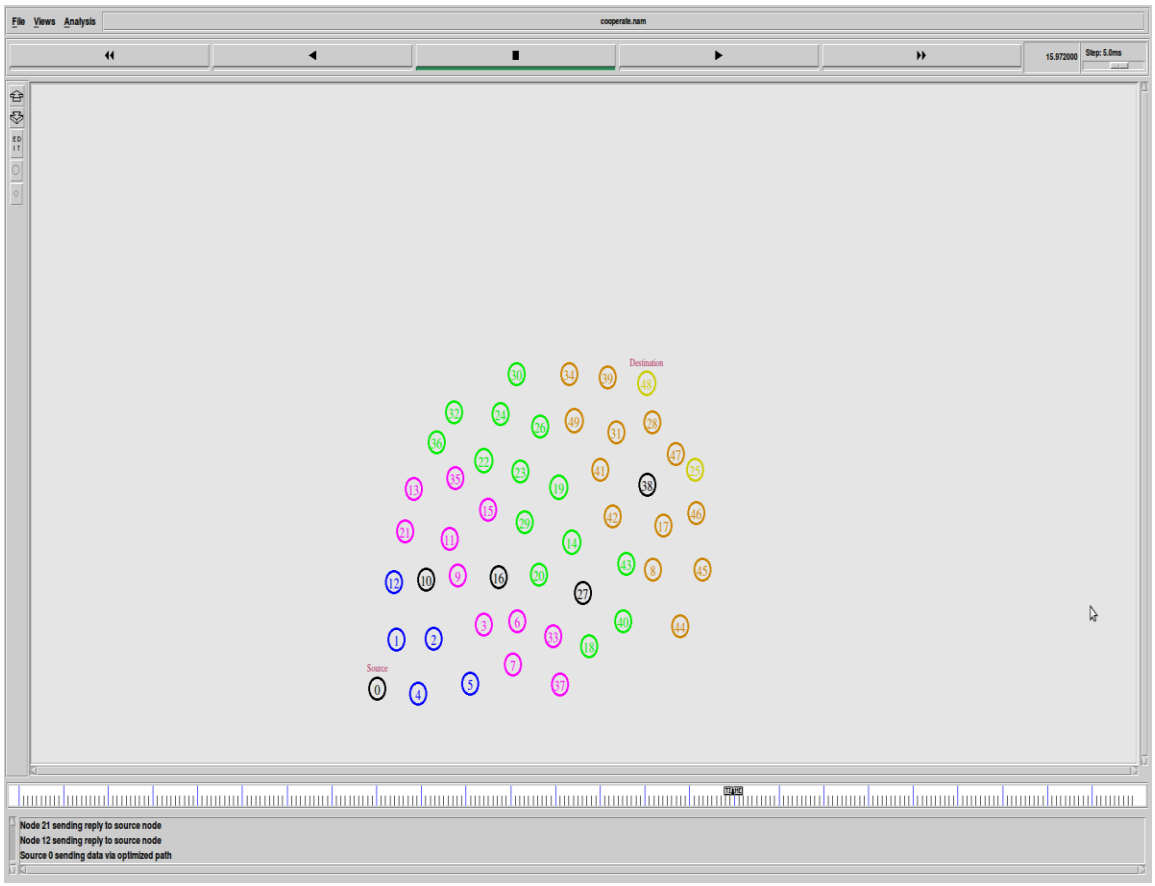

Figure 4.13: Path selection in existing scheme

Fig 4.13 shows the path (consisting of the nodes in the black color) selected using the existing scheme.

CHAPTER 5

RESULTS AND DISCUSSION

The suggested scheme in addition to the existing scheme was applied using open source simulator NS 2.35. The network simulator is used to simulate various real time network scenarios for mobile ad hoc networks, vehicular ad hoc networks and wireless sensor networks etc. The simulation of the proposed and existing schemes has been done using input parameters shown in the table 5.1:

Table 5.1: Simulation Parameters

Parameter	**Value**
Channel	Wireless
Mac	802.11
Routing Protocol	AODV
Number of nodes	50
Queue	Drop Tail
Initial Average Energy	44 Joules
Propagation Model	Two Ray Ground
Antenna	Omni Directional

- **Average End to End Delay**: It is the time taken for the packets to reach from the source to destination node over the selected path.

$$EndtoEndDelay = Packetreceivingtime - PacketSendingtime \quad (5.1)$$

Figure 5.1: Average End to End Delay Comparison

This graph 5.1 shows the values of the end-to-end delay parameter obtained for both the schemes. It indicates the time taken by the packet to reach from source to destination node. The value for Average End to End Delay is 0.054 sec. (approx.) for the proposed scheme, and 0.0825 sec for the existing scheme indicating that the proposed scheme outperforms the existing scheme in terms of Average End to End Delay.

- **Remaining Energy**: This represents amount of energy remaining in the network. More is the value of this parameter, better is the network lifetime.

$$Remaining\ Energy = Initial\ Energy - Energy\ Consumed \quad (5.2)$$

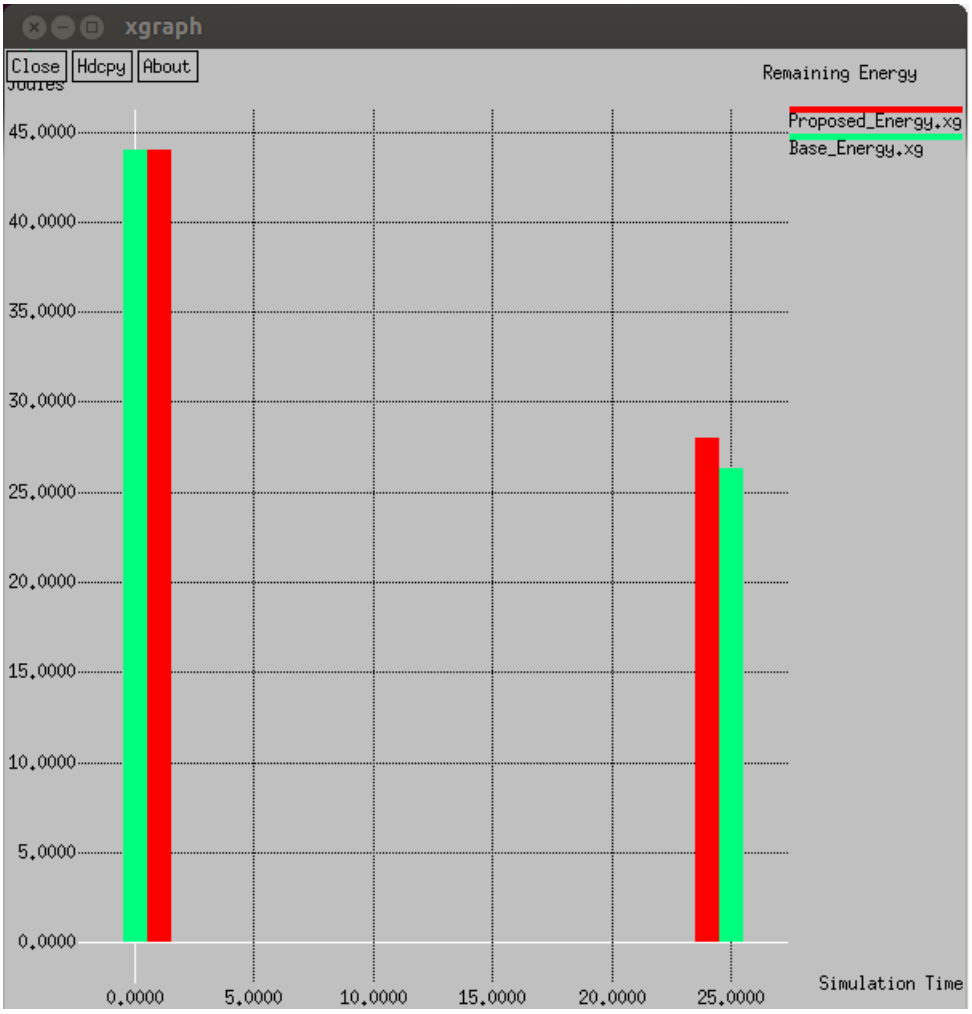

Figure 5.2: Remaining Energy Comparison

This graph 5.2 demonstrats the energy remaining in the network. Initially the average energy provided to the network was 44 Joules and at the finish of the simulation the residual energy for the proposed scheme was found at 28 Joules approx. and for the existing scheme, it was found at 26 Joules. Thus, it shows that lesser energy is consumed with the proposed scheme.

- **Packet Delivery Ratio**: defined as fraction of the sent packets that were effectively delivered at the destination node. Mathematically it is defined as

$$PDR = \frac{Number\ of\ datapackets\ received}{Number\ of\ data\ packets\ sent} \quad (5.3)$$

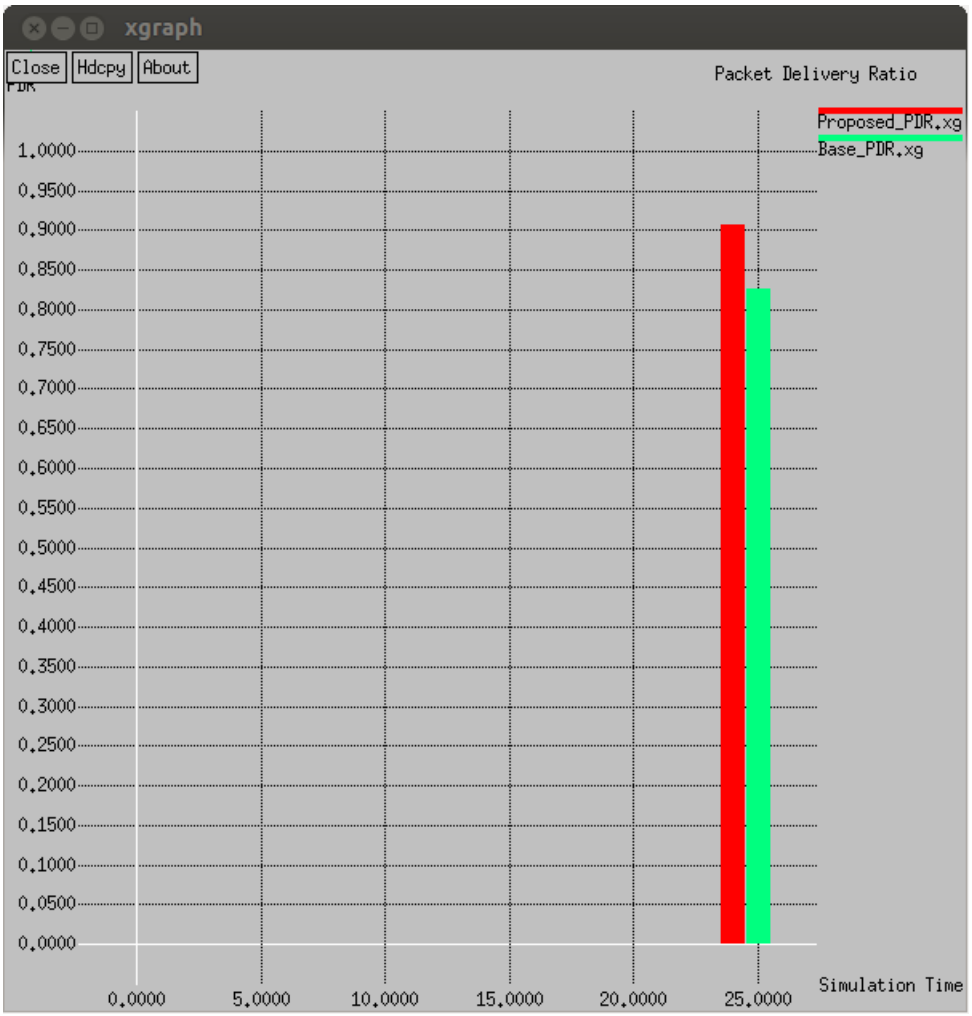

Fig 5.3: Packet Delivery Ratio Comparison

The value of PDR for the proposed scheme is higher (at 92 percent) than the existing scheme (at 83 percent).

- **Throughput:** Throughput is the quantity of information acknowledged at destination node for every unit of time. It is normally measured in Kbps. Mathematically, it is computed as

$$Throughput = \frac{Number\ of\ datapakets\ received * Packetsize\ in\ bits}{1000} \quad (5.4)$$

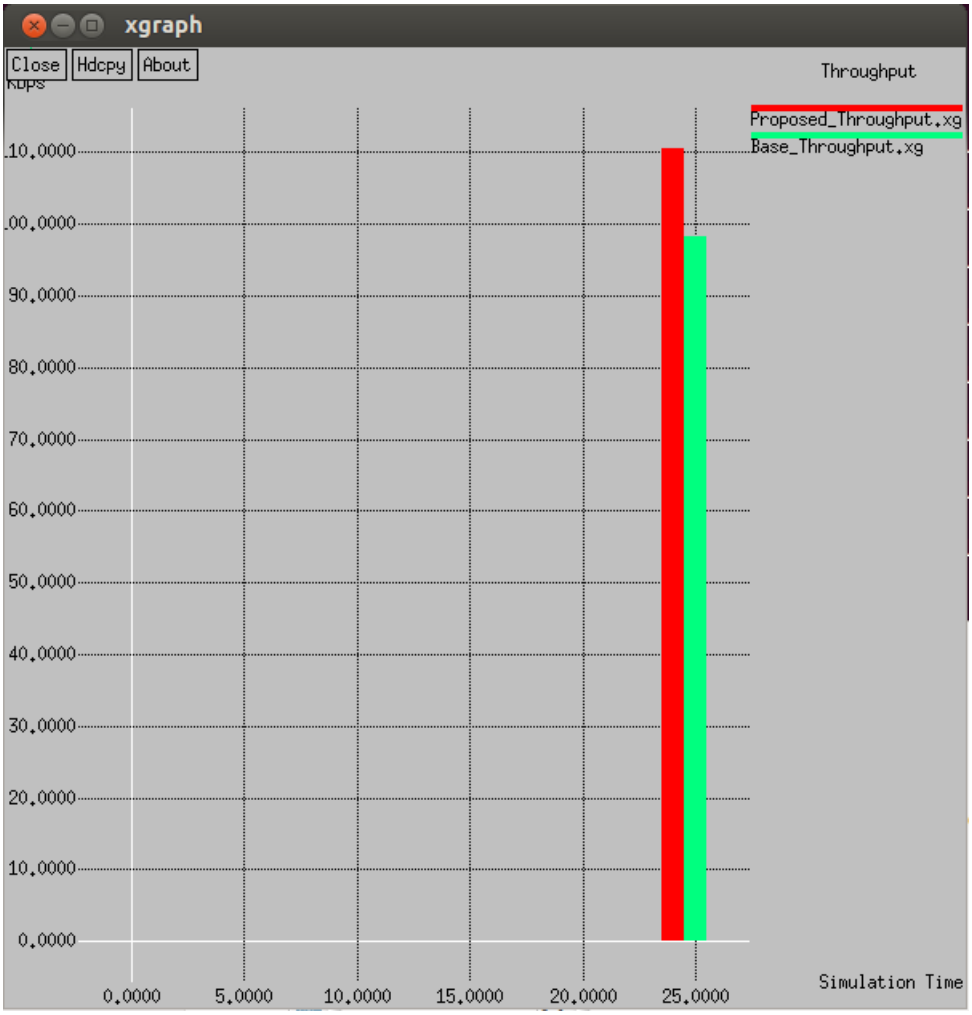

Fig 5.4: Throughput Comparison

Throughput value is higher for the proposed scheme (at 110 Kbps) than the existing scheme at (98 Kbps).

Table 5.1 Comparison of values of Packet Delivery Ratio, Throughput, Remaining energy and Avg. E2E delay

	RA-AODV	**Proposed Scheme**
Packet Delivery Ratio	0.82	0.92
Throughput	98 Kbps	110 Kbps
Remaining energy	26.2932 Joules	28.0526 Joules
Avg. E2E Delay	0.08243 Sec	0.05443 Sec

CHAPTER 6

CONCLUSION AND FUTURE WORK

The aim of the work is to improve the lifetime of the network. Various schemes have been proposed on the reliability of the network, but majority of them had not considered the network lifetime. In this thesis, a novel scheme has been proposed for routing considering various performance parameters. The performance of the scheme has been analyzed based on residual energy of the network, packet delivery ratio, throughput and average end-to-end delay. The proposed scheme shows lesser energy consumption than the existing scheme. The reason for this improvement is attributed to the fact that the projected system practices the concept of the flexible transmission range of the nodes. The energy consumed by any node depends on the distance of the communication between the node and its pair. If the distance is less, than energy consumed is also less. Since, much of the energy is depleted in broadcasting process, the nodes in the proposed work, reduce the transmission range if their residual energy is less. Therefore, energy consumed in the broadcasting process is reduced, leading to lesser remaining energy and higher network lifetime.

The packet delivery ratio was found higher, and since higher packet delivery ratio means more amount of packets get effectively conveyed at the destination, so the throughput also displays higher values than the existing scheme. The end-to-end delay also showed lesser values for the proposed scheme. The reason for this can be attributed to the fact that the existing scheme first considers those shortest paths for which end-to-end delay is minimum and bandwidth is higher, then after filtering out the paths, it considers those paths for which the movement of the nodes in the route is minimum. In the proposed scheme, these factors are accounted at the same time. Thus, it optimizes the path selection process in the better way, which is evident from the value of the parameters obtained.

Thus, it can be concluded that the planned scheme is superior to the present scheme. This work, however, does not take into account any security aspect of the mobile ad hoc

networks. These networks suffer from numerous assaults such as black hole attack, wormhole attack, gray-hole attack, flooding attack *etc*. The proposed scheme can be modified in the future in a way that it can detect these attacks, thus making network more secure.

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REFLECTIVE DIARY

December, 2016

After the exams of EST we got to know that we have to give a seminar on the topic of thesis. Before this I was just studying various topics and was bit careless but when the notice of the seminar came I started searching for the topic seriously and finalized my topic. then I got my topic approved by my guide. For the thesis we had to prepare a seminar report and presentation .I gave my presentation and was satisfied with my performance .After this we had our winter vacations so we went back to our homes.

January, 2017

Now the holidays were over. It was study time now. Till date I knew my topic that I had to work on MANETS. I started reading research papers and gathering more and more matter. Finally after working for several days I came up with and proper and complete idea what I wanted to do. I discussed it with my guide. And Thank god my guide also approved it. I was very happy I felt as if half of my job was done. Now I only need to implement it.

February, 2017

Next the difficult task was to bring the idea I had on paper into implementation.It was not that easy I found it really very difficult to install various softwares that I needed.It took a lot of my time installing those.once it was done I took a break of 2 days and relaxed .After this next was coding.

March,2017

I had to implement the base paper and my own proposed work both and then compare the results.While doing this task I faced difficulties sometimes I got stuck

up because of my silly mistakes but still the work kept going and I was able implement my proposed work and finally I got the results as desired. They showed an improvement over the existing work.

April, 2016

After this I started writing my paper as I have to send it in the mid of April. I found it a bit challenging to write a good research paper in such a short duration of time. I read some research papers and took help from my guide and somehow I was able to complete it and send it before deadline. After sending the paper I started waiting for the acceptance notification which was to come on 30 April. I was a bit worried also.

May,2017

While waiting for the notification I started working on my thesis report. So I collected a large amount of data for this purpose. In middle of all this I kept trying to make my results more accurate and proper, observe various others parameters to refine my results .I finally got the acceptance notification yuppie !but have also got some reviews so started making the mentioned changes in my paper and sent back the amended paper. Now the conference is in June so I again started working on my thesis. All the things were going pretty well. As planned.

June ,2017

This is the Thesis summation month, we have to sum up all the research on implementation tasks for final thesis submission. Along with this I have to attend my conference. Thus I prepared for the conference and it was also a good experience. After this I completed my report writing and prepared video presentation ,posters and peer reviews.

LIST OF PUBLICATIONS

- Baljinder Kaur, Shalini Batra and Vinay Arora "ERA-AODV for MANETs to Improve Reliability in Energy Efficient Way", 2017 Springer's International Conference on Smart Innovations in Communications and Computational Sciences.

LINK FOR VIDEO

- https://youtu.be/0a18vhsP01I