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ENERGY EFFICIENCY ROUTING FOR MANET USING RESIDUAL ENERGY

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Abstract: Communication is possible by either framework dependent or free. One of the frameworks free communications in wireless technology is wireless ad hoc networks. This contains devices that are spread over the network radio region. When two devices are within radio range of one another, they can communicate with one another without the use of a third device. If both are not in wireless range of each other, they must rely on other communication devices for communication. This situation causes the MANET device to act like a router to provide communication. For this, nodes must have sufficient resources such as buffers, energy, and processors. Energy resources are one of MANET's limited resources. MANET's primary applications are the military, disaster relief, and law enforcement. In these applications, resource conservation is a major issue because the device's battery cannot be recharged or replaced during the mission. A different number of mechanisms at different levels of communication have been developed for efficient use of energy. Routing is the ultimate way to manage MANET energy resources. Therefore, various energy-aware routing protocols have been designed and developed by MNAET to manage network energy during communication. This article explores various energy-efficient routing protocols for MANETs and evaluates their performance against various performance metrics. This article focuses routing protocols based on the residual energy of nodes.NS2 stimulator is used to find out network performance. The results gave the way for future research to develop energy-efficient communications in MANETs to increase network lifetime.

Keywords: Wireless communication, MANET devices, battery, efficient mechanisms, residual energy, network simulator 2 (NS-2), network lifetime.

I. Introduction:

MANET consists of various mobile bumps which use radio communication. A situation in which a technical network can be used in cases of natural disasters such as earthquakes and storm and flood tide damage, information exchange, Routing is done through a multi-hop network. The intermediate hosts forward the data packets to their final positions, which also belong to the relay nodes. In order to save the traditional battery life, the power management method is the first choice to use it successfully. Therefore, power consumption is an important issue in MANETs, which sometimes fail due to limited battery power, which affects the life cycle of the entire mobile network. Therefore, to prolong the lifetime of the network of MANETs, we must conserve energy. save routes in mind to reduce network power consumption. Energy.

The best method for lowering power consumption when delivering data over a wireless peer-to-peer network is Energy Efficient Routing. In general path often uses energy to transport a data packet from source to destination node.But,it must alter certain set of network hiccups or comprise of dependability of routes. Quality can be improved by finding a reliable path. On the other hand, taking into account the node's residual energy in routing can prevent node abuse and ultimately extend the network lifetime

II. Related work:

The method presented J.-H. Chang et.al [1]. The authors present a theoretical framework and describe a new algorithm for finding the optimal routing policy for analyzing the problem of lifetime optimization, but does not address other important aspects of wireless sensor network design and its performance. The paper relies on certain assumptions and limitations. The method presented "Energy Efficient Routing with Unreliable Links in Wireless Networks" by X. Li et al. [2] presented a routing algorithm that considers the energy consumed by each node and the chance of failure of the link to improve the energy efficiency of the network. The method proposed “Link Estimation and Routing in Sensor Network Backbones: Beacon-Based or Data-Driven?” by H. Zhang, et al. [3] focuses on the link estimation and routing aspects of sensor networks by comparing and does not consider other important issues such as security and data aggregation, which are also critical for practical sensor network applications. The method presented by "Reliable and Energy-Efficient Routing for Static Wireless Ad Hoc Networks with Unreliable Links" by X.-Y. Li et al. [4] proposed a routing protocol that dynamically selects a subset of nodes as relays to establish reliable end-to-end communication paths with low energy consumption. The proposed protocol may not perform optimally in dynamic ad hoc networks where node mobility is high and link quality changes frequently. The method proposed "On Accurate Energy Consumption Models for Wireless Ad Hoc Networks" by J. Zhu et.al [5] on linear model that considers the energy cost of transmitting and receiving a single data packet and an exponential model that accounts for the energy cost of the entire data packets transmission process. It does not consider other important issues such as network connectivity, scalability, and security, which are also critical for practical wireless ad hoc network applications. The method proposed "On Accurate Measurement of Link Quality in Multi-Hop Wireless Mesh Networks" by K.-H. Kim et.al [6] focused on propose a link quality measurement technique that takes into account the interference from neighboring nodes, the channel noise. This may limit the scalability of the technique in large-scale networks or resource-constrained devices. The method proposed "A Kalman Filter Based Link Quality Estimation Scheme for Wireless Sensor Networks" by M. Senel et.al [7] presented a approach that adds received signal strength and packet error rate measurements to estimate link quality. The assumption that the quality of the link can be modeled as a linear system, which may not hold in the presence of non-linear interference or fading effects. The method presented “Reliable, Low Overhead Link Quality Estimation for 802.11 Wireless Mesh Networks,” by L. Verma, et.al [8] a novel scheme that utilizes a combination of packet transmission success rate, received signal strength indicator, and interference level to estimate link quality. The proposed scheme may not be suitable for all types of wireless mesh networks, as its

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effectiveness may depend on the specific characteristics of the network, such as topology, traffic patterns, and interference levels.

III. Proposed work:

In this paper energy efficiency, reliability, and extending the network lifetime in wireless ad hoc networks is considered. Two novel energy-aware routing algorithm, called reliable minimum energy cost routing (RMECR) and reliable minimum energy routing (RMER) is proposed.

RMECR is a routing protocol that considers multiple quality of service parameters, like delay and loss rate of a packet, while considering the residual energy of each nodes. This protocol selects a path which consumes least energy while traversing while satisfying the QoS requirements. RMECR achieves this by maintaining a set of candidate paths and selecting the path with the minimum energy consumption. RMER is a multi-path routing protocol that distributes traffic over multiple paths using the residual energy of nodes. This keeps multiple nonoverlapping paths between the starting and the ending nodes and selects the path with the highest residual energy to forward the packet. This allows for more efficient use of nodes with higher residual energy, thus extending network lifetime. Both RMECR and RMER rely on the residual energy of node to make routing decisions. This approach helps to balance power consumption of nodes, thus increasing network lifetime and may not be suitable for all MANET applications. This methodology includes simulation time, number of nodes and throughput, packet forwarding speed and energy efficiency using the following routing protocols.

3.1 Energy-Aware Reliable Routing

Development of reliable power-based routing algorithms for Hop-By-Hop (HBH) and End-to-End (E2E) systems. The focus is on finding a path that minimizes the energy cost of passing E2E packets while considering reliability. If the path reliability is low, power consumption is high due to packet retransmission. Two algorithms are proposed: "Reliable Routing with Minimum Energy" and "Reliable Routing with Minimum Energy Cost". This EEAR (Efficient Energy-Aware Reliable Routing) multi-metric optimization optimizes multiple metrics simultaneously, including power consumption, reliability, latency, and throughput. This optimization helps improve overall network performance by balancing various metrics and incorporating new mechanisms and optimizations that improve power efficiency and reliability in wireless networks. The figure 1 and 2 represents the Sequence diagram and activity diagram for Energy-Aware Reliable Routing.

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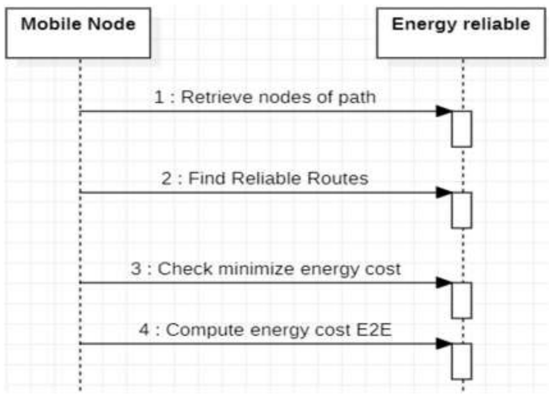


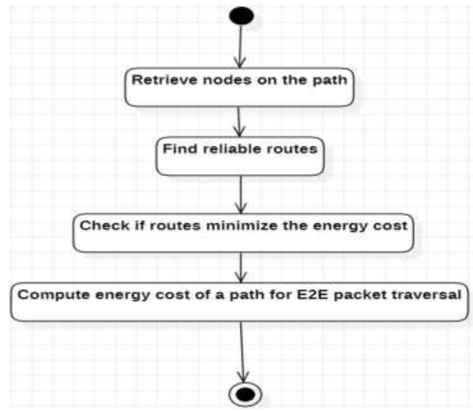
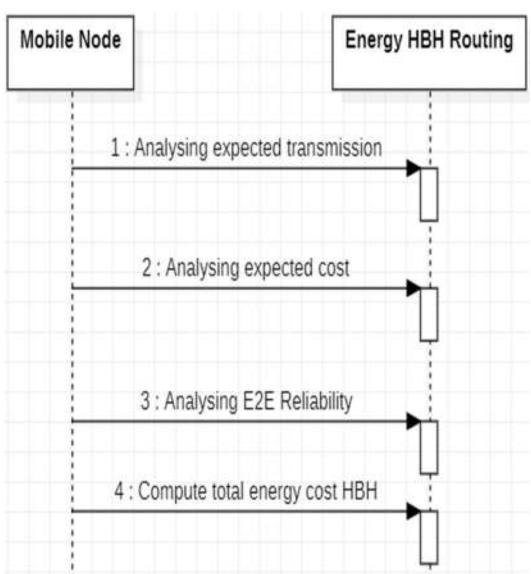


Fig 1: Sequence diagram for Routing Energy Aware Reliable Routing

Fig 2: Activity diagram for Energy-Aware Reliable

3.2 Energy Aware HBH Routing

The focus is on finding a route which has low energy cost of passing E2E packets while considering reliability. Reliability is related to power cost. If the path reliability is low, power consumption is high due to packet retransmission. The RMER and RMECR algorithms operate on a layered design routing protocol similar to EEAR, and EEAHHR also uses a layered design that allows information to be exchanged between different protocol layers to improve routing efficiency. This design allows the protocol to make better decisions about power consumption and data transmission reliability. The figure 3 and 4 represents the Sequence diagram and activity diagram for Energy-Aware HBH Routing.



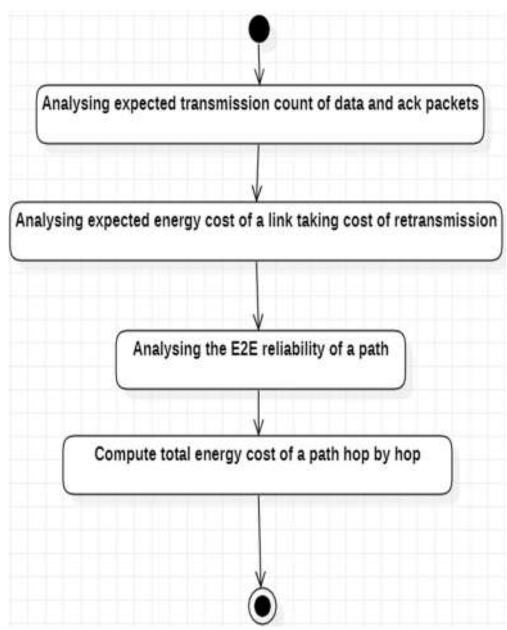
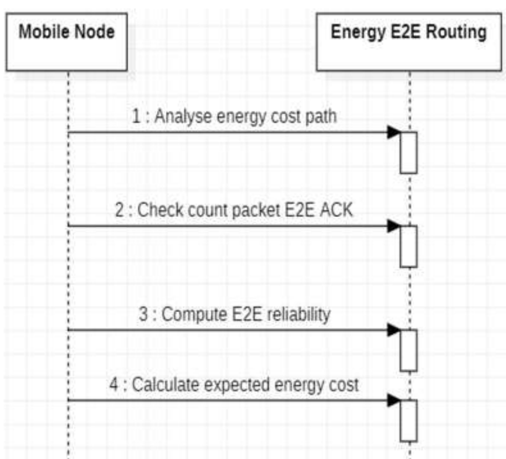


Fig 3: Sequence diagram for energy aware HBH routing **Fig 4**: Activity diagram for energy aware HBH routing

Energy Aware E2E Routing

The path's energy cost is analyzed based on the number of transmissions of E2E ACK packet data and the reliability of the path. Two assumptions (H1 and H2) are made about the effect of E2E ACK on energy costs. H1 assumes the E2E ACK has no effect, H2 considers its effect. Estimated energy cost is calculated by multiplying the estimated energy cost per transfer by the number of expected transfers based on the assumption (H1 or H2). The energy cost calculation is done recursively on H2.

The currently working protocol is Adaptive Link Rate Control (EEE2E), which includes an adaptive link rate control mechanism that adjusts the data rate based on link conditions. This mechanism helps to increase the reliability of data transmission while minimizing power consumption. Figure 5 and 6 represents t Sequence diagram And activity diagram for energy aware routing. diagram for Energy-Aware E2E Routing.



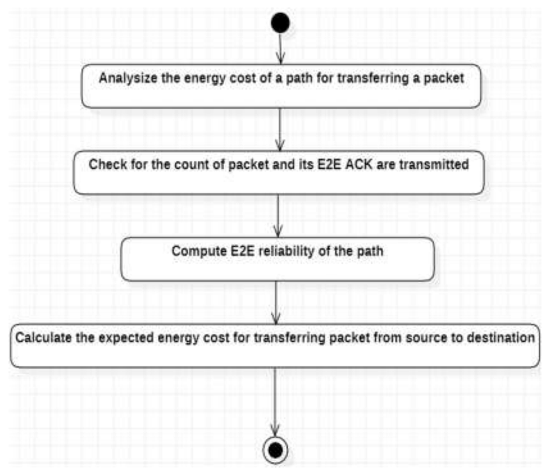


Fig 5: Sequence diagram for Energy Aware E2E Routing

Fig 6: Activity diagram for Energy Aware E2E Routing

IV. RESULTS AND DISCUSSION:

Specifically, power productive and solid directing is the most significant plan criteria for remote adhoc organize since portable hubs will be controlled by batteries with restricted limit. The power disappointment of a portable hub influences the hub itself as well as its capacity to advance parcels in the interest of others and furthermore the general system lifetime. Expanding the power productivity, unwavering quality and system lifetime is the disadvantage in the Traditional least power steering (TMER) and minETX (expected transmission count). Reliable least power directing (RMER) and Reliable least power cost directing (RMECR) are proposed to accomplish the above necessities of remote adhoc arrange.

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In this part, it depicts test results and discourses on the reproduced outcomes. It additionally thinks about the exhibition of the calculations in remote system.

A TCL document is utilized to make a system situation which contains the data with respect to topology estimate, number of hubs and setup of hubs and parcel data, power model, hub's underlying power, steering convention, directing component and traffic examples to course the bundles which create follow records and NAM record. NAM records when executed picture the reproduction of system.

ns order is utilized to run TCL documents which associates with the mediator and permits TCL methodology to be summoned at self-assertive focuses in reproduction time.

The TCL records when executed produces the accompanying NAM and follow documents as per the convention characterized in it. The conventions utilized in my activities are:

i. Traditional least power routing (TMER)

ii. Minimum Expected transmission check (min ETX)

iii. Reliable least power directing (RMER)

iv. Reliable least power cost routing (RMECR)

Beneath figures shows the following document yield as per proposed conventions showing hub power, sort of traffic, position of hubs and so forth.

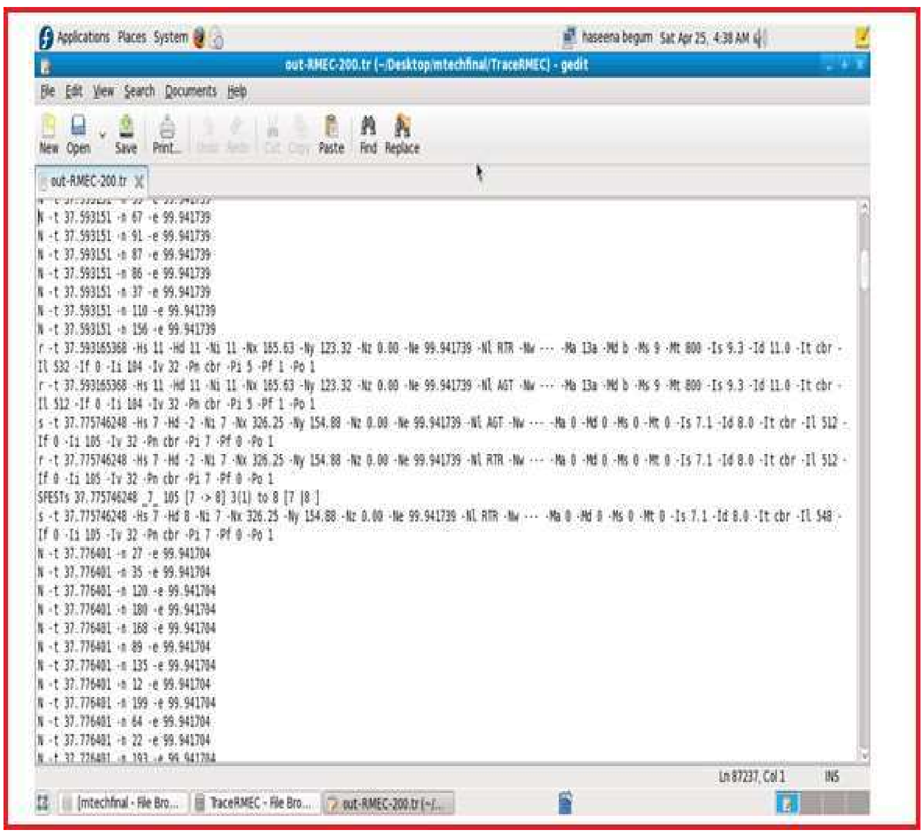

Fig 11: RMEC Trace file

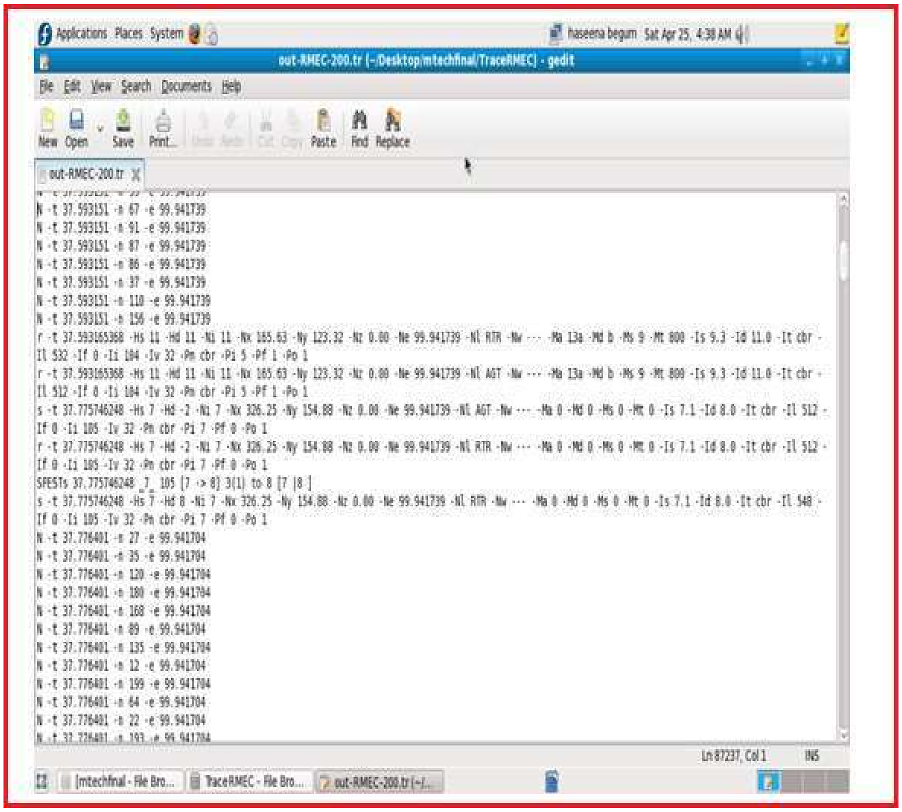

Fig 12: RMEC Trace file

NAM is a TCL/TK based animation tool that is used to visualize the ns simulations and real-world packet trace data. The first step to use NAM is to produce a nam trace file.

The figures below show the simulation of node environment specified in TCL file according to proposed RMEC and RMER of 200 nodes with CBR (constant bit rate) traffic.

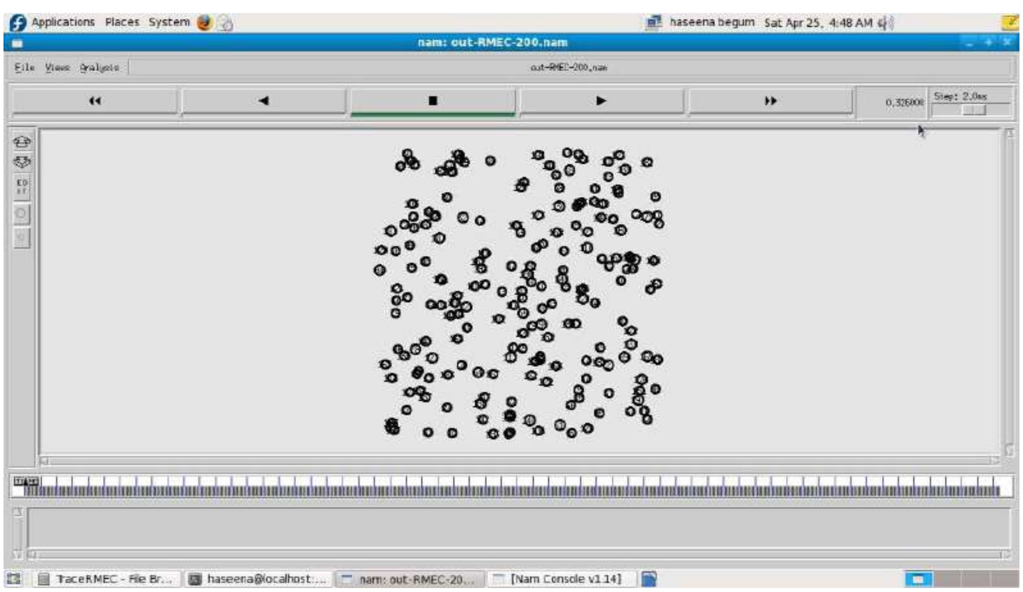

Fig 13: Display of network scenario of RMEC

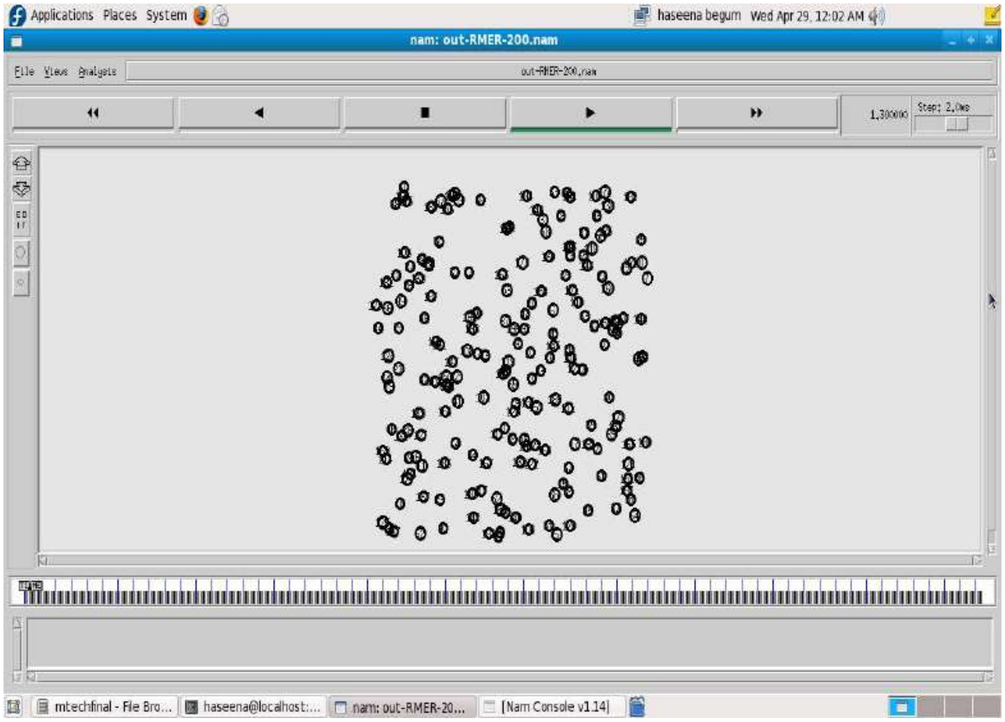

Fig 14: Display of network scenario of RMER

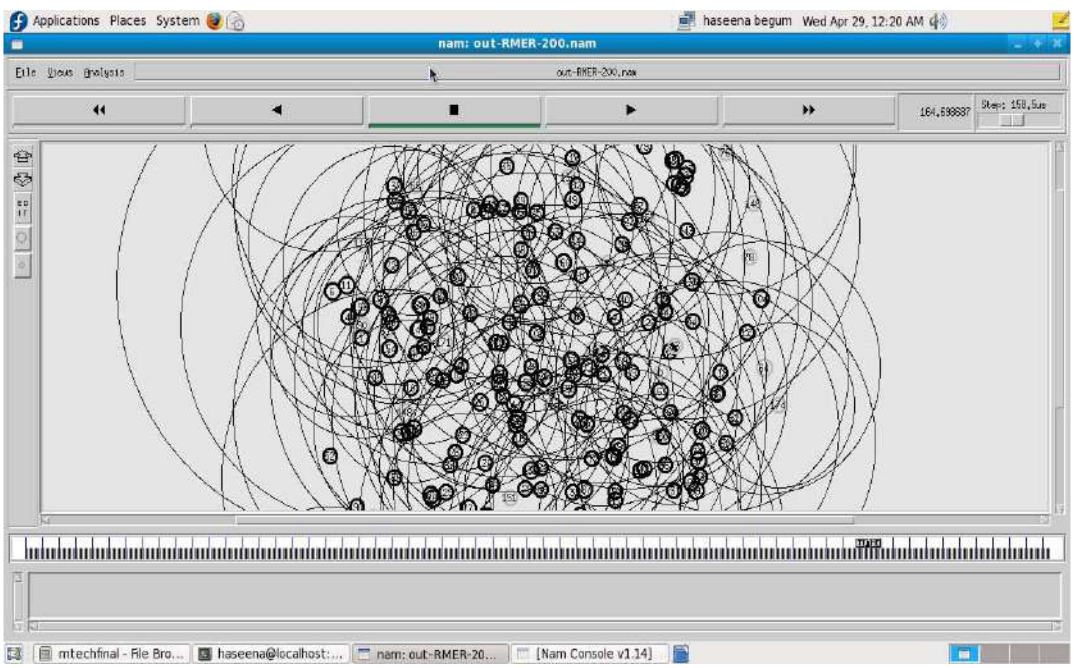

Fig 15: Processing of packets in the network

Performance Evaluation

To evaluate the performance the implemented protocols are compared with the existing protocols. The trace files generated is used and using awk scripts various parametric values are collected and graphs are plotted using GNU plot. GNU Plot is a free, open-source software package for creating plots and charts. It is a command-line driven program, which means that users enter commands to create and customize their plots. The program can be used to create 2D and 3D plots of data and functions, including scatter plots, line plots, bar charts, and histograms.

GNU Plot supports a variety of file formats for input and output, including CSV, TSV, and ASCII. It also supports a wide range of terminals for output, including PNG, JPEG, PDF, SVG, and more. The program is highly customizable and allows users to change the appearance of plots by modifying various parameters, such as line types, colors, and font sizes. GNU Plot also includes built-in functions for fitting data to various models and performing statistical analysis. GNU Plot is widely used in scientific research, engineering, and data analysis, as well as in education and other fields. It is available for various platforms, including Windows, Mac, Linux, and more.

The metrics used for protocol comparison are.

i. **Packet delivery fraction:** The ratio of number of data packets successfully received by CBR destination to the number of packets generated by the CBR sources.

ii. **Energy consumption:** The energy consumed by the nodes while transmitting and receiving data and control packets.

iii. **Reliability of routes:** The maximum the number of data packets successfully received by the destination, the high is the reliability of routes.

iv. **Network lifetime:** The duration of time the network is alive.

To plot graphs using GNU plot paste all the graph values in src directory in Gnu plot directory and then navigates to gnu plot terminal. Fig 14 shows navigating to gnu plot terminal

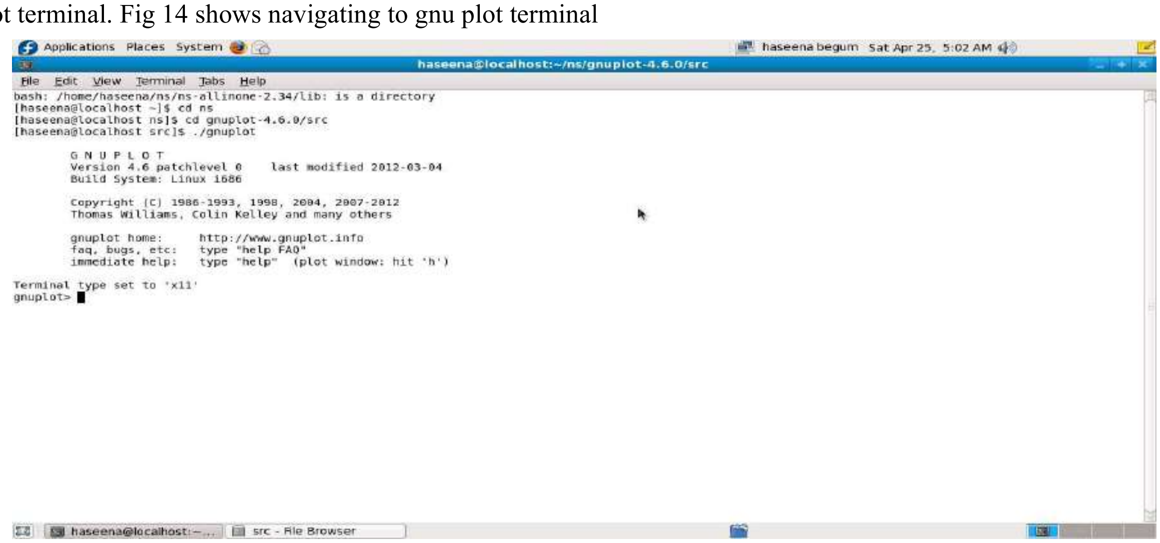

Fig 16: Navigating to GNU plot terminal.

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XGraph is a graphical tool for displaying and analyzing network data. It is a tool used to plot and visualize data in real-time, such as network traffic or performance metrics. XGraph is typically used in the field of networking research and development, but it is also used in other fields such as finance, physics, and engineering.

Now we are comparing lifetime of the distance vector algorithm of the packets how it is transferring from the source node to destination node. Here in this Xgraph we can observe network lifetime in seconds on Y-axis and number of nodes on X-axis. We can see sharp increase in the network lifetime. As number of nodes increases the lifetime increases rapidly.

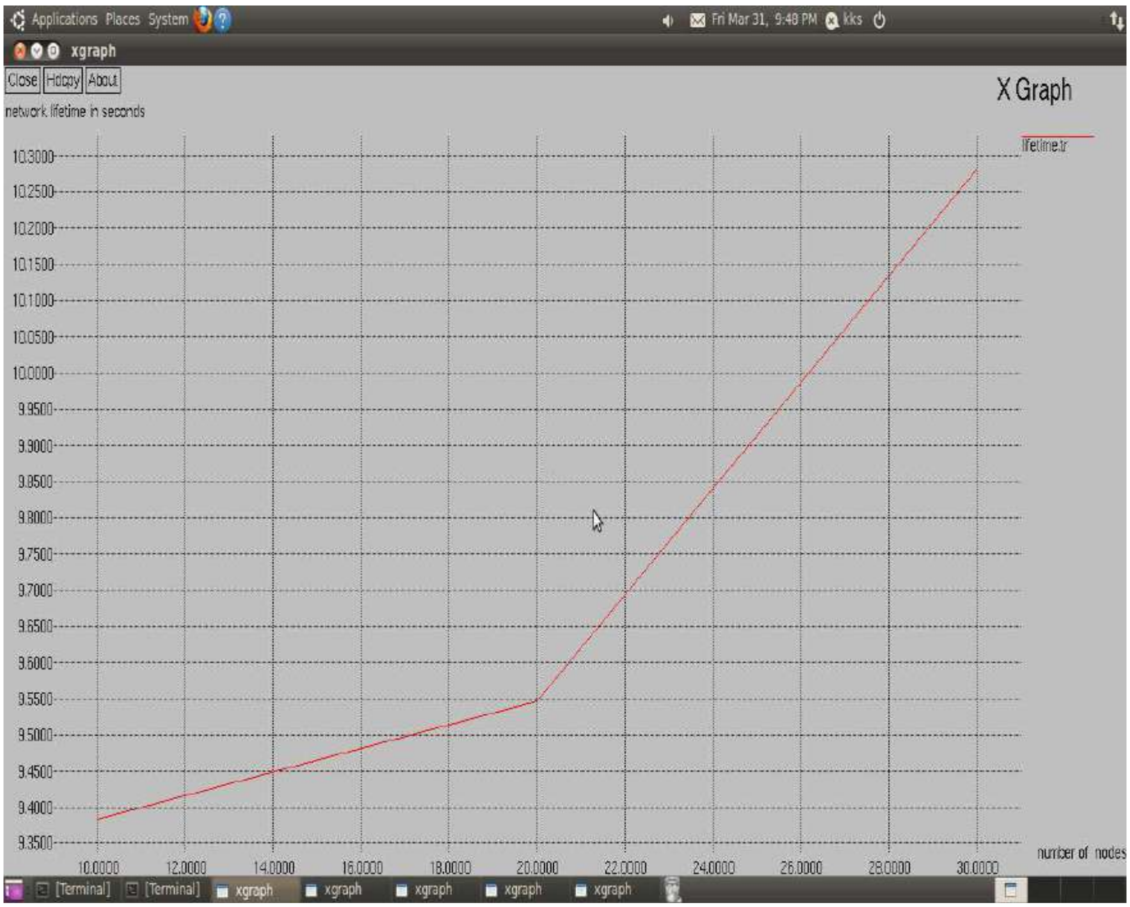

Fig 17: Xgraph of lifetime network on distance vector routing algorithm

Now we are comparing lifetime of the Energy efficient routing algorithm of the packets how it is transferring from the source node to destination node. Here in this Xgraph we can observe network lifetime in seconds on Y-axis and number of nodes on X-axis. We can see sharp increase in the network lifetime. As number of nodes increases the lifetime increases rapidly.

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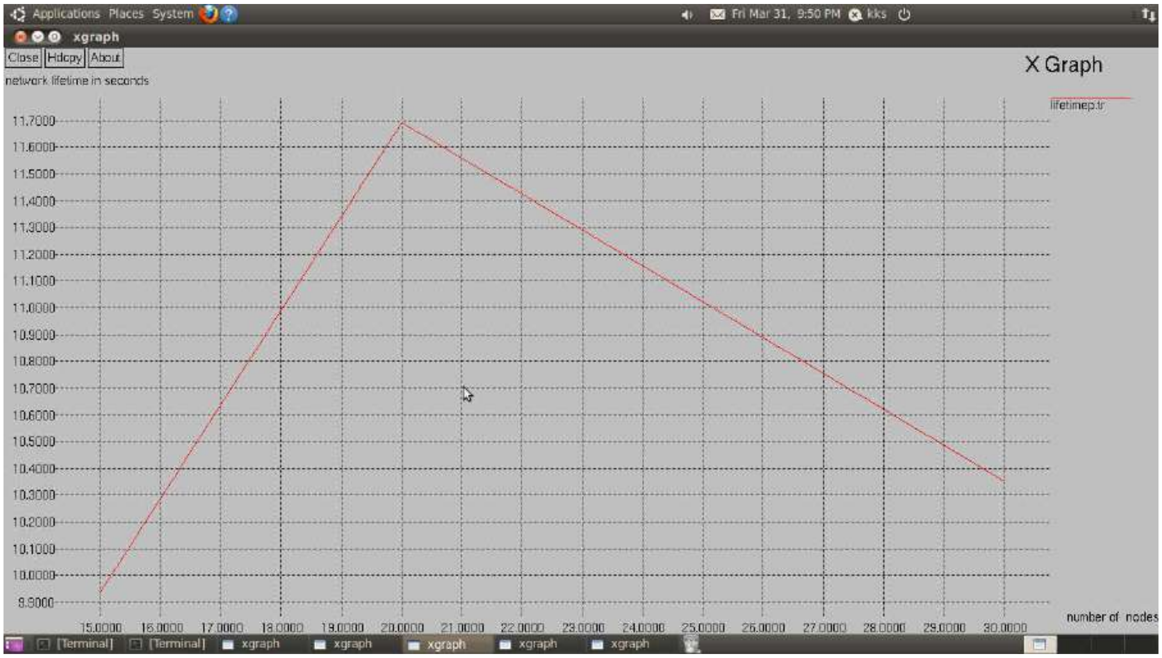

Fig18 : Xgraph of lifetime network on the Energy efficient routing algorithm

On observing both the graphs and comparing them we can observe there is an increase in network lifetime in MANNET. By this we can say the energy efficient routing algorithm works better and used in increase of lifetime.

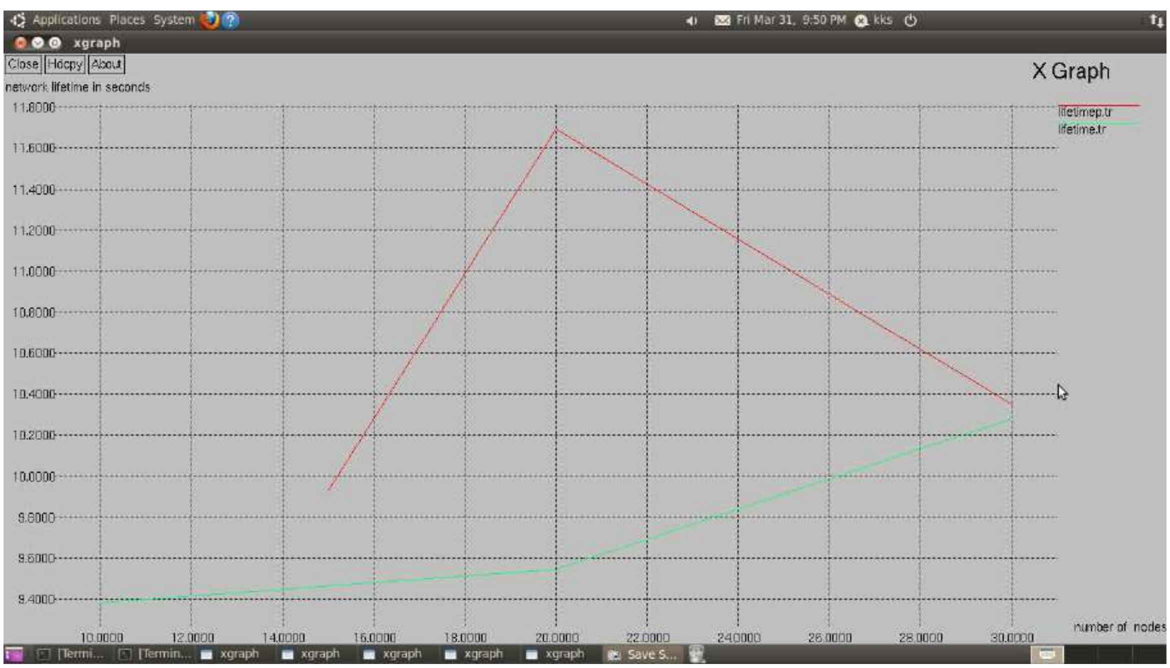

Fig 19: Comparision of both alogorithms in network lfetime

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No. of nodes	Network lifetime	
	lifetime.tr	lifetimep.tr
10	9.4	0
12	9.43	0
14	9.47	0
16	9.5	10.3
18	9.58	11
20	9.59	11.7
22	9.7	11.4
24	9.83	11.9
26	10	10.86
28	10.18	10.6
30	10.23	10.36

As we observe in the table we can see the network lifetime similar but the energy consumption is high and unstable in lifetime of distance vector routing algorithm. But whereas the energy efficient routing protocol has maintained stable helped in increase of network lifetime.

Throughput is a measure of how much data or how many units of a product can be processed or transferred within a given amount of time. In computing, throughput refers to the amount of data that can be transmitted over a network or processed by a computer system in a given time period. It is usually measured in bits per second (bps) or bytes per second (Bps).

Now we are comparing lifetime of the Energy efficient routing algorithm of the packets how it is transferring from the source node to destination node. Here in this Xgraph we can observe throughput in joules on Y-axis and number of nodes on X-axis. We can see sharp increase in the throughput. As number of nodes increases the throughput increases rapidly.

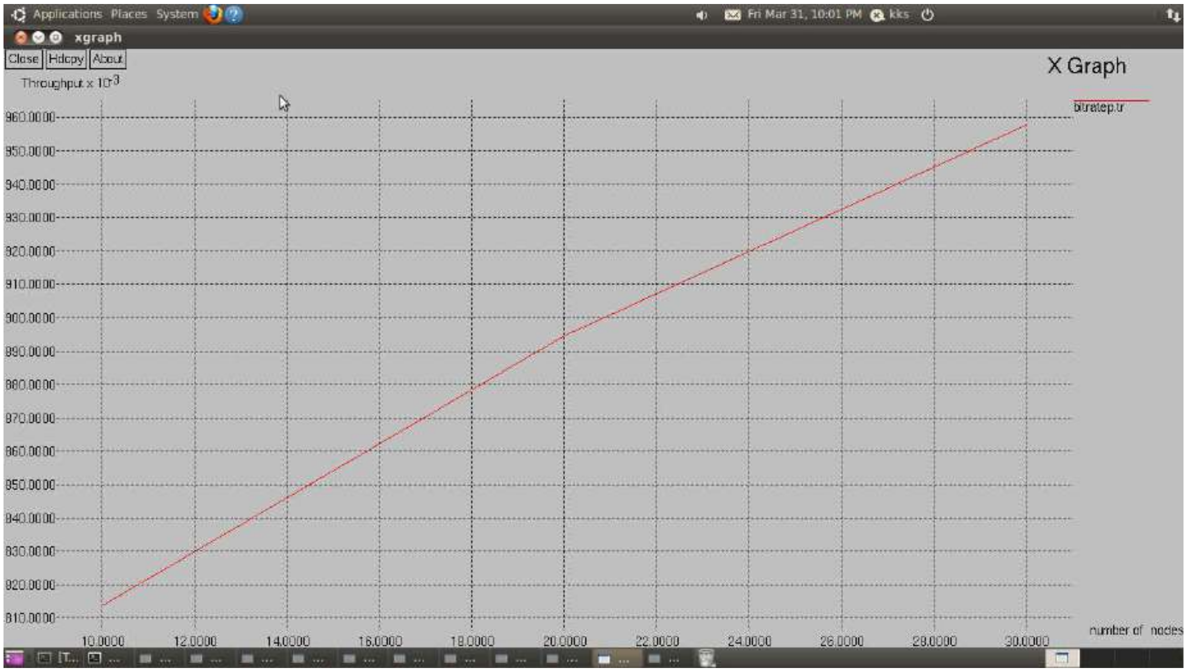

Fig 20: Xgraph of throughput network on the Energy efficient routing algorithm

On observing both the throughputs and comparing them we can finalize there is an increase in successful transmissions and perfect data transfer in MANNET. By this we can say the energy efficient routing algorithm works better and used in transfer of data without loss.

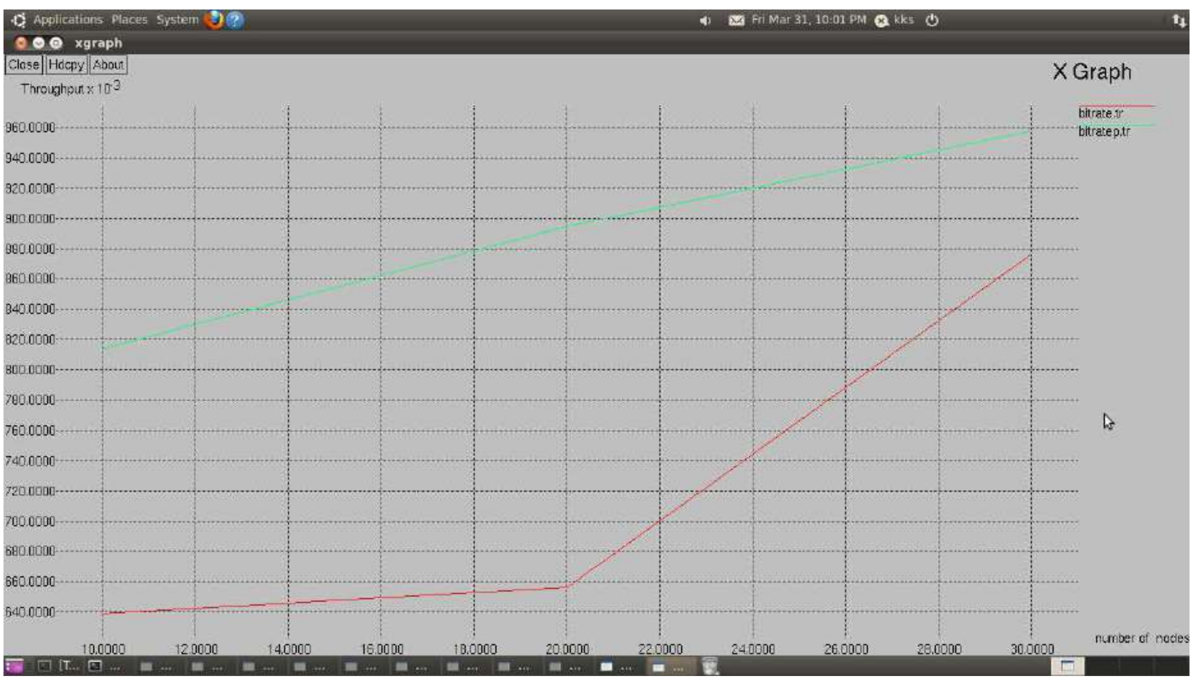

Fig 21: Comparision of both alogorithms in throughput of network

No. of nodes	Throughput	
	biterate.tr	biteratep.tr
10	640	818
12	32	830
14	649	848
16	650	860
18	653	880
20	658	893
22	700	910
24	742	920
26	789	934
28	836	942
30	876	960

As we observe in the table we can see throughput bitrate transfer in distance both routing algorithm is increasing . But whereas the energy efficient routing algorithm has high values and great successful transmission without packet loss in a given time.

In the NS-2 simulator the packet size which is transferred between 200 nodes is 512bytes. As we have observed simulation time is 200 seconds with no pause time. As we set constant bit traffic at packet rate transfer of 1 packet per second. In the initial the packet energy has 100J it transfers the packet with high reliability in 70 meters transmission range without retransmissions with less consumption of energy to destination. further information about increased efficiency achieved is as tabulated below.

Simulation parameters	**value**
simulator	NS2(2.34)
Topology area	350*350
Packet size	512 bytes
Nodes	200
Pause time	O sec
simulation	200 sec
Maximum connections	10 flows
Packer rate	1Packet/sec
Initial energy	100 joules
Transmission range	70 mts
Tx energy	0.1

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Rx energy	0.1

V. CONCLUSION AND FUTURE SCOPE:

This new protocol improves the performance of MANET networks, especially in terms of network lifetime and residual energy utilzation. The design and development of the protocol considers the overall power consumption model of nodes and routing paths in the network. Compared to existing energy-based routing protocols, the protocol has been shown to outperform these existing solutions.

The protocol proposed in the study can be improved further by studying how power allocation and energy-efficient routing interact with unreliable wireless connections. The purpose of these proposals is to minimize overall energy consumption by optimizing power distribution and communication paths. These proposed methods can be further developed for various communication scenarios such as Reliable Link Layer Unicast, Multipath Routing or Multicast Routing.

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