ZBLE: “Energy Efficient Zone-Based Leader Election Multipath Routing Protocol for MANETs”

Rani Sahu, Sanjay Sharma, M. A. Rizvi

Abstract: Inside the paper, an analysis of the representation of a zone-based multipath routing technology called Zone-Based Leader Election Energy Constrained AOMDV Routing Protocol (ZBLE) for MANETs has been presented. The primary purpose of the MANETs is to make system communication effective and efficient so that the quality of the network can be ensured. Consumption of energy in the MANETs has extended been a larger problem since the past. Movable devices present into the wireless environment are dependent on batteries and cannot fulfill the power supply due to limited power capacity. To address this problem, we have used zone-based technology which is designed by modifying the AOMDV protocol. Inside here, the demonstration about a zone-based system for the wireless network has been analyzed which is called Zone-Based Leader Election Energy Constrained AOMDV Routing Protocol (ZBLE). It has been implemented for energy efficient communication based on energy label, node tracking, and power analysis. It is a zone-based technology that works in keeping with the energy of multipath routing in mind. ZBLE protocols prolong the network's life by reducing balanced energy consumption between nodes. This protocol is compared to the traditional route protocol i.e. AODV and AOMDV, in which it has been found that the ZBLE protocol presents better results.

Index Terms: Energy Efficient Technology, MANETs, AOMDV based Routing Protocol, Zone-Based Methods.

I. INTRODUCTION

Mobile Ad-Hoc Network had become very popular because of the development it did in the field of technology, research, and academics. None of the communication structures already present in the MANET network is found. In this network, nodes are distributed freely and randomly, which are connected through a wireless link. Every node present in the network works as a router. [1,2] Nowadays, the use of wireless devices in most applications has increased significantly in the last few years, due to which the amount of data transmitted from these devices is too large and there is a possibility of further development. Researchers have proposed various techniques and route protocol [3] to adjust the requirements of these increasing data volumes and

Improve the efficiency of these wireless networks. Most of the routing protocols inside the network are utilized to determine the path. With the help of only one Path Protocol, only one route can be obtained from the origin node to the target node and maintained. A specific standard is AODV. The AODV protocol is highly suited to dynamic networks. [4-6]

Researchers [7-9] say that the shortest way to use the Hop Count criteria in a single path is not the best route in MANET. Multiple paths of one origin to one target are obtained by the Multi-Path technology [10-11]. The main purpose of reliable communication, efficient use of system resources and load balancing is the multipath routing protocol. Many paths are obtained from the help of Multipath Protocol [12], if the path fails, packet transmission can be easily turned on with backup paths. The example of this protocol is AOMDV. Network resources can be saved using multipoint technology. This type of routing is more complex than wired networks and it is a daunting task [13, 14].

Considering the problem of energy consumption, energy consumption has been prevented by using zone-based multipath routing systems [15]. In this type of network, wireless resources like mobile nodes use battery power, which is restricted. Due to the large scale use of some nodes, their battery power expires soon, so that nodes are not worth the use in the future and such nodes reduce the real achievement of the system. The battery power regarding the device present into the path selected from single path routing ends soon because it routing using the same path. This protocol reduces the growth of that system. Such a problem regarding single path technology can be avoided with multi-path routing technologies. Therefore, multi-path technologies are wider popular in wireless networks. In previous related tasks, keeping the energy in the AOMDV protocol in the wireless network, a lot of research has been done in comparison to the existing protocol [16- 17].

Keeping in mind the problems of all these protocols, we are implementing the Zone-Based Protocol, All the nodes in this network have been randomly distributed, in which the leader node denotes elected based beside the higher effectiveness nodes. To elect a more stable path, this technique uses high power nodes bypassing the weak energy node.

Our aim is to use such protocols in wireless networks through zone-based technology, which helps maximize network life span by minimizing energy consumption in nodes in the network.

Optional lessons can be used if the path fails in communication through this technology. In this network, only high energy and power nodes are included in the communication so that the packet can be strongly transmitted of the origin to the target without delay.

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This paper uses zone-based architecture for communication in wireless networks. Using that technology, we are analyzing to boost the current outcome of the multi-path AOMDV protocol procedure. In our effects, we are involved in growing the benchmark inside relation to several existing parameters keeping within mind the throughput, delay (end to end), energy consumption, and network life. With this changed methodology, our network is effective to produce reliable performance parametric evaluation toward wireless networks. In this paper, we have demonstrated better ZBLE protocol, which improves network performance by zone based energy technology. This paper has been arranged in the following manner: Inside the 2nd section, we have described ZBLE protocol. Within 3rd section, we explain several steps of ZBLE Protocol with an algorithm and methodology. Section 4 includes an Energy Consumption Model. Section 5 contains a representation regarding the simulation environment and experimental settings and Section 6 represents the Results including discussion. Conclusively, within Part 6 concludes the paper.

II. ZONE BASED LEADER ELECTION ENERGY CONSTRAINED AOMDV ROUTING PROTOCOL (ZBLE) DETAILS

The ZBLE protocol based is divided into several areas on network decomposition. The main goal of this protocol implies have energy consumption within mind so that up gradation of the performance of the life of the system can be done. The principal role of this protocol is to elect the genuine energy route by obtaining energy, power and node tracking. In Figure 1, all the steps in the ZBLE protocol are illustrated through the base layout.

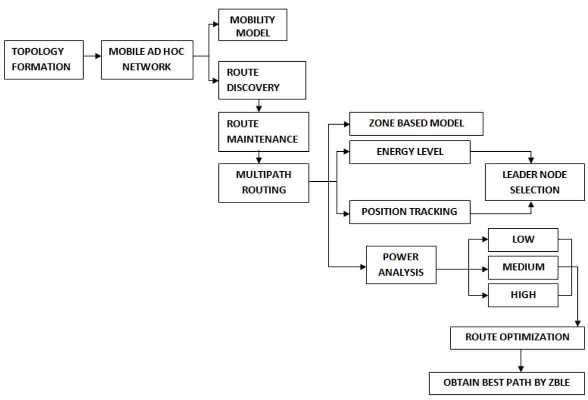

Fig.1. Block Diagram of ZBLE

The topology of this scenario is designed under MANET. The nodes have been moved randomly using the random mobility model. Several routes have been provided through the multipath route discovery process. But with the help of a zone-based model, some of the best paths have been selected. The path obtained by the zone-based model has been selected by modifying the path with the help of power label, position tracking and power analysis of existing nodes. In this protocol, energy labeling and position tracking have been used to select the leader node. The status of the leader node is shown in Fig. 2.

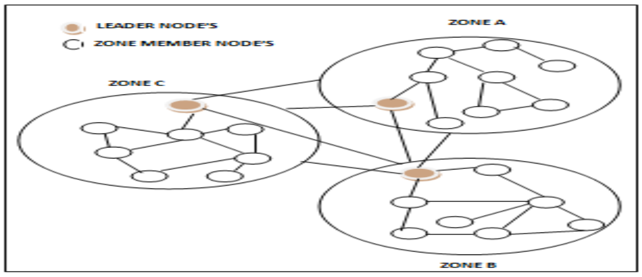

Fig.2. Leader nodes position in Zone Based Technology

After selecting the Leader node, zone-based technology has been optimized to find the best path by classifying power Analysis into lower, middle, and high-level three labels.

III. ZBLE SYSTEM MODEL

Zone-based technology has been selected to efficiently utilize the energy resources of nodes. Zone-based technology has been used to reduce consumption of node on a wireless network by selecting a leader node and zone member node. Leader node has been selected based on energy label, power analysis and node position tracking system in this protocol. Figure 6 shows the ZBLE system model. In this system model, the number of devices, the dynamics of the devices, the initial energy concerning the devices, the packet size and the protocol name are given in the form of input parameters. Information related to packet information, MAC layer information, and energy of the node has been obtained in the form of output.

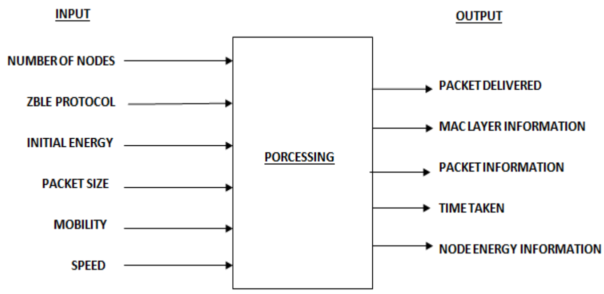

Fig.3. System Model of ZBLE

In this paper, zone-based multipath routing algorithms have been introduced to enhance the efficiency of MANET. Here the network area is divided into several areas so that the energy of each participating mobile node can be preserved. To achieve network scalability, mobile nodes have been employed by selecting them in areas based on energy. In each zone, a leader node is selected which monitors the zone and sends data to the next zone.

To communicate in a network, the source and destination address need to be identified. After identifying the source and destination, the position of the beginning and end of the node is determined. Using the dynamic model, obtaining the information of the nodes, selecting the leader node and zone members after the representation of the power signal has been checked.

By analyzing the power analysis on the basis of the Leader node, transmission power, and reception power, the next node is selected using maximum node density, minimum dentistry, and maximum node size. Using RSS value, the best route has been selected.

IV. MODEL OF ENERGY CONSUMPTION

Our object toward this part is to define complete energy, which is required during strongly assigning a bit regarding data. Energy modeling or energy system modeling is used to build and analyze computer models of energy systems. The energy model is used in the ZBLE protocol. This energy modeling is based on theoretical energy consumption. Here we are examining the packet formation under the communication operations. Then we will use the mathematical formula to get complete energy consumption by examining the elements of energy consumption. it can be estimated in the following ways. Like due toward the release and gathering of energy packets, the energy consumed in processing and that energy also included, which would have been spent by nodes in idle mode. [18]

A. Packet formation

The common arrangement of the packet formation applied in communications operations is shown by fig 4. The whole number of bits inside a pack is expressed by Lp. Every packet of header H bits has been taken including necessary release parameters, in which OPHY acquisition has been used for physical overhead signals. Tracking (channel estimate, synchronization, etc.) and physical payloads have been addressed with NPHY bits. The physical payload consists of the Mac Data Payload (NMAC) and overhead (OMAC), so essentially frame controls, addressed areas, and packet sequence numbers [19].

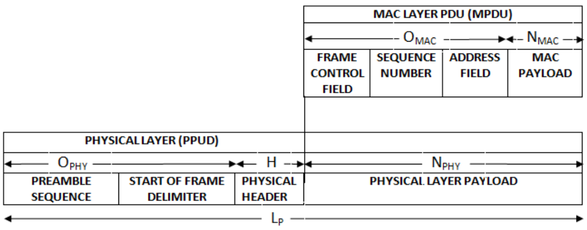

Fig. 4. Packet Formation through Physical Layer including MAC Layer

The total number of bits in a packet (LP) can sometimes be expressed as raw Bit Rate (Rr) as LP = RrTP. RA is the bit rate behind eliminating headers including overheads and many bit bits per-packet (NMAC) are expressed by

NMAC = RA Tp, It is defined as

RA = (NMAC / LP) Rr (1)

The possibility of a Ps error, the product of the entire possibility of progress (1 - Ps) and NMAC (1 – Ps) can be estimated to the predicted outlay of data per hosted packet.

B. Calculate Energy Consumption for Packet Transmission

When the packet goes from each node on the way, it is necessary to know the amount of electricity consumed by the packet. The energy consumed to send / receive packets by node for data forwarding can be calculated as follows [20].

$$EC = \sum_{k=1}^{n} T(nk, nk+1) \quad (2)$$

Transmit / receive energy consumed in packet is represented by T (nk, nk + 1).

C. Calculate Node Remaining Energy

Rk = Fk – Econsume_energy (t) (3)
Fk = Total Energy of node
Econsume_energy = Consumed energy of each node

D. Energy Calculation

All these energy can be obtained from the below mentioned formulas.
ZEnergy Transmission = ZEnergyXT × t (bits) + ZEXP (d2) (4)
ZEnergyReceiving = ZEXR × t (bits) (5)
ZEnergySleep = ZEXS × t (sec) (6)
TotalEnergy = ZEnergyTransmission + ZEnergyReceiving + ZEnergySleep (7)
In equations 4, 5, 6 and 7, energy per bit for transmission has been addressed with ZEnergyXT. Energy consumption per bit per acquisition has been addressed by ZEXR, to find the next hop neighbor is referred to ZEXP (d2) and energy consumption per second in idle mode is shown with the help of ZEXS. Total energy consumption can be successfully measured per bit of transferred from the model shown above. Without error, the power transferred through the transmitter regarding through bit forwarded frames transferred to the recipient is given via:

Fk = total amount of energy consumed / Complete cost of data delivered.

E. Calculate Total Energy of Path

$$Energy\ (p) = \prod_{k=1}^{n} (Rk(t)/Fk) \quad (8)$$

Where Rk (t) denotes remaining battery capacity including Fk implies charged battery capacity about intermediate device k, at time t. the purpose of that metric stands maximizing energy metric.
This is one of the more obvious metrics [21]. The amount of energy which is consumed through whole the packets from the origin device to the target device should be degraded to conserve energy.

V. DESCRIPTION OF SIMULATION ENVIRONMENT & EXPERIMENTAL SETUP

A. Simulation methodology

An open-source event-driven simulator for displaying the dynamic nature of the communication network was designed for research in 1989, known as NS-2.

It continued produced through the University of California on Berkeley. NS-2 does use on a wide scale through various government, private organizations, industry, and academics. Simulation of both the wired and wireless networks can be simulated by this.

It supports two main languages C ++ and Object-Oriented Tool Command Language (OTcl), the backend of simulation objects are defined by C ++. OTcl assists in gathering and configuring objects. The Tcl file of NS2 presents text-based or animation-based results after being run. Values of network parameters have been achieved by reading the trace file through the AWK script. Animation-based results are a .nam file which can be seen on the NAM (Network AniMator) window. With the help of XGraph, the results can be displayed graphically [22].

VI. Node Formation

A. Movement model

Mobility models play an important role in determining protocol performance. They are used to describe patterns of mobile nodes present in the network, their location. These models work on the basis of two attributes velocity and acceleration. [23]. These models can also be modified in the case concerning they are spatial and temporary dependencies.
i) Local dependency - depends on the frequency of the device. These models work with high spatial dependence when two nodes proceed in the same direction
ii) Temporary dependence - It is measured on the basis of current velocity (magnitude and direction) and previous velocity. Any two nodes have a high floating dependency, similar velocity and direction.
Generally RWM, RPGM, MGM and GMM Mobility models are used. For running mobile nodes random waypoint model is used. In the defined topology area, data forwarding is done by selecting the destination at random speed. The mobile node stops again when it reaches the destination for time stopping, choosing another destination and proceeding.

B. Random Waypoint Model

In this model a destination is randomly chosen by each node and is usually used. In this one moves forward using an equal distribution (0, Vmax), the maximum allowable velocity for each node is represented by Vmax. Using each node 'pause time', the length of the defined period Stops for, after this, it again prefers a random target and repeats the whole method until the outcome regarding the simulation.

C. Communication Model

We choose continuous bit rate (CBR) for traffic sources. Continuous bit rate (CBR) traffic is unreliable; there is no guarantee of transmission to data destination because it has no connection establishment steps. No such acknowledgment is used for confirmation in this type of traffic. [24]
The nodes are spread randomly on the network. 512-byte data packets have been used. The scenario has been simulated by generating 100 nodes in this paper. Simulation parameters are presented by Table 7.

Table 1. Simulation parameters and node configuration

PARAMETER	VALUE
Type of the Channel	Wireless Channel
Radio Propagation Model	TwoRayGround
MAC type	802_11
Interface queue type	DropTail/PriQueue
link layer type	LL
Antenna Model	OmniAntenna
Max packet in ifq	50
Number of mobile odes	100
Routing protocol	AODV, AOMDV & ZBLE
Energy set up	EnergyModel
X dimension	1507
Y dimension	732
Time of simulation end	100, 200, 400, 600
Packet size	512
Initial Energy	50
Rx	0.035
Tx	0.035
Speed	3

Energy Model
Energy performance in the protocol can be influenced by various energy models. The two ray ground radio model has been implemented in this paper. In this model, threshold has been denoting by dcrossover.
Energy required to transmit the message of k bit in length d is:

$$ZEtx\ (k, d) = k\ Eelec + K * € \ Zfriss\text{-}amp\ d2\ (d >= dcrossover) = k\ Eelec + k * € \ two\text{-}ray\text{-}amp * d4\ (d >= dcrossover)) \quad (9)$$

Energy to get k bit message:

$$ERX\ (k) = Eelec * k \quad (10)$$

Eelec is the energy consumption of transferring or obtaining circuits of per bit of information. The € Zfriss-amp implies the power amplification coefficient regarding the energy transmission model.
Energy models have been simulated by the transmission power, receiving power and idle power. The specific value is displayed from the help of Table 2.

TABLE 2. Energy models values

Transmission Power	Receiving Power	Idle Power	Initial Energy(EI)
0.035 watt	0.035 watt	0.100 watt	50 Joules

VII. Screenshots of Network Topology

Screenshots from the network topology of simulation scenario is given in Fig. 5.

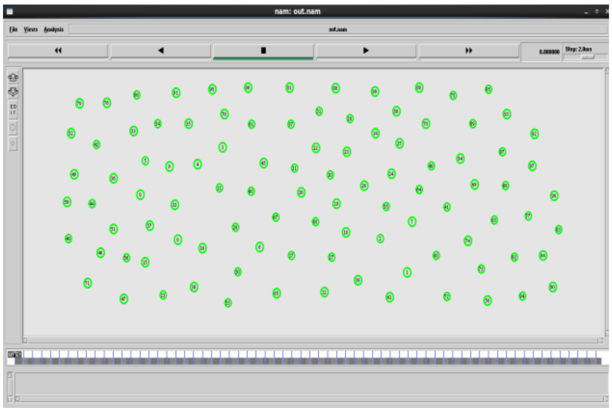

Fig. 5(a) shows the initial random distribution of the devices within the area.

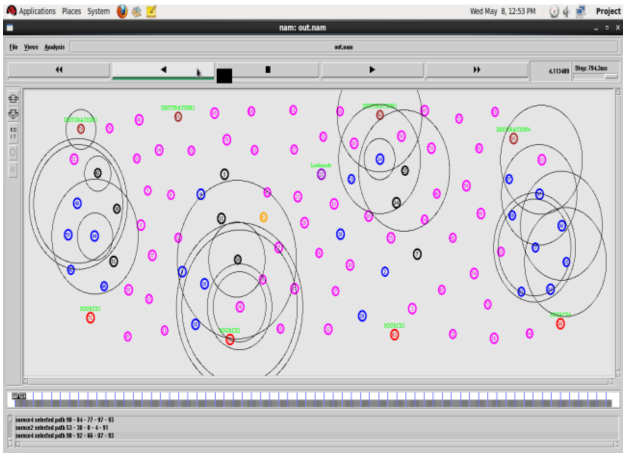

Fig. 5(b) illustrates the process of ZBLE Protocol

Fig..5. Network Topology Simulation Scenario

VIII. RESULTS AND DISCUSSIONS

In this section we have analyzed the results of various matrixes. Network performance metrics [25, 26] are defined. The actual value of the result is shown in a tabular manner. The graphs have been obtained by these values, which are shown in this section.

A. Throughput

Throughput can be defined as the rate at which the given message can be successfully sent through the network on the communication channel. This implies estimated within bits per second (bit / s or bps), and sometimes the data per second implies also measured in packets or data packets with packets. The calculation of throughput is done in the following manner:

Throughput = ((number of received bytes * 8)/ simulation time) * 1000kbps

Table 3 has been shown throughput for three routing protocols. Figure 6 shows that the throughput of ZBLE implies the greatest compared to the different two protocols. Increases throughput during implementing ZBLE.

Table 3. Throughput comparison on different simulation time

SIMULATION TIME	THROUGHPUT		
	AODV	AOMDV	ZBLE
100	1878.74	1600.40	5606.00
200	3350.47	3759.32	9615.30
400	7576.81	7098.72	14495.65
600	11863.74	11218.82	16920.86

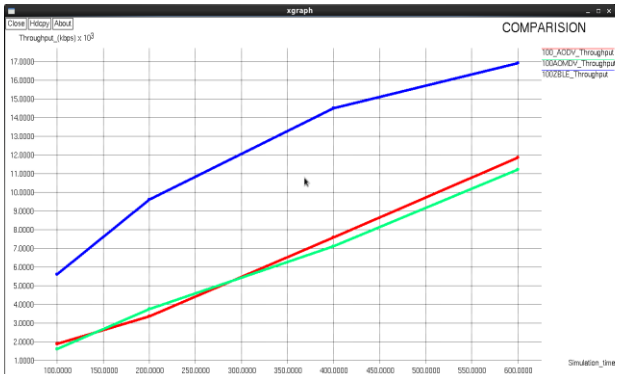

Fig. 6. Throughput comparison

B. End To End Delay

Any packet from the source layer of the origin, how much time required traveling to target's application layer of the target, that indicates to the delay(end-to-end). It is measured in milliseconds. There are many delays in processing with routing latency. This delay is included in all types of lines queued in the interface queue; Publicity and transfer time; Delay in MAC retracement; and buffering during route detection latency. The formula described below is to calculate E2E delay.

End To End delay = $\sum_{k=1}^{n}(Rk - Sk)/n$

The value of the three protocols is displayed in the table 4. Based on these values, the graph of figure 7 illustrates End-To End delay, in which the difference between ZBLE, AODV and AOMDV is shown. The ZBLE routing protocol performs better because the source node always selects routes using the maximum energy node.

Table 4. End to End Delay comparison on different simulation time

SIMULATION TIME	END TO END DELAY		
	AODV	AOMDV	ZBLE
100	850.84	948.506	573.368
200	563.457	830.658	414.553
400	499.49	783.374	455.78
600	561.462	762.031	447.898

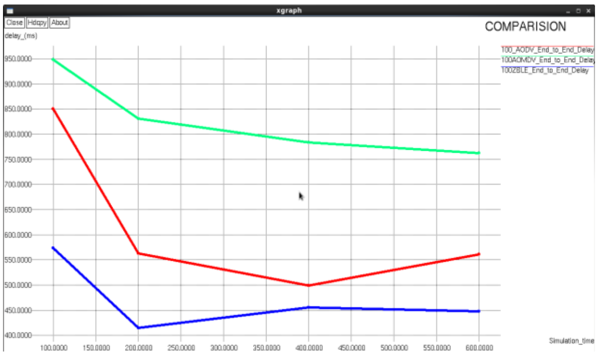

Fig.7. End To End Delay Comparison

C. Energy Consumption

The amount of energy consumed within the simulation time by the network node is referred to by energy consumption. The simulation is achieved by calculating the energy level of each node after running to the end. It is measured as the amount of energy (j). The following formula can provide energy consumption value:

Energy Consumption = $\sum_{i=1}^{n} Z\_ini(i) \; - \; Z\_ene(i)$

The value of the three protocols is displayed in the table 5. Based on these values, the graph of figure 7 energy consumption has been shown, in which the difference between ZBLE, AODV and AOMDV is shown. Here ZBLE displays good performance because it is designed to choose from the highest energy source.

Table 5. Energy consumption comparison on different simulation time

SIMULATION TIME	ENERGY CONSUMPTION		
	AODV	AOMDV	ZBLE
100	157.634	157.991	153.871
200	165.384	165.304	158.169
400	180.99	180.604	165.849
600	196.709	196.558	173.537

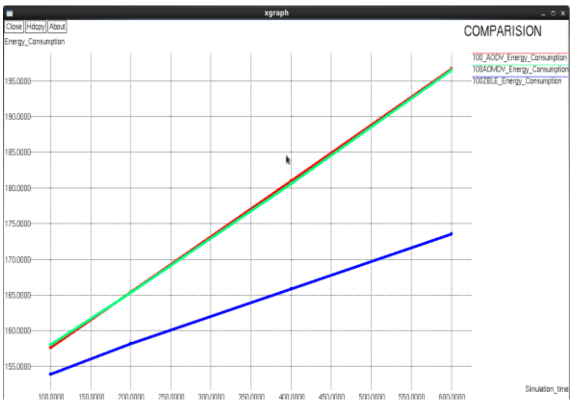

Fig.7. Energy Consumption comparisons

D. Network lifetime

The time required to eliminate the battery of N mobile nodes in any network is known from a network lifetime. All Lists of Network Protocols are shown in the table 6. And on the basis of these values, it is represented in the graph 8 by representing it in the graph form. ZBLE's lifetime is larger than AODV and AOMDV. Network life can be increased from the ZBLE protocol.

Table 6. Network Lifetime comparison on different simulation time

SIMULATION TIME	Network Lifetime		
	AODV	AOMDV	ZBLE
100	42.3658	42.0088	46.2503
200	34.6159	34.696	42.2398
400	19.0102	19.3958	34.5968
600	3.29084	3.44159	26.5234

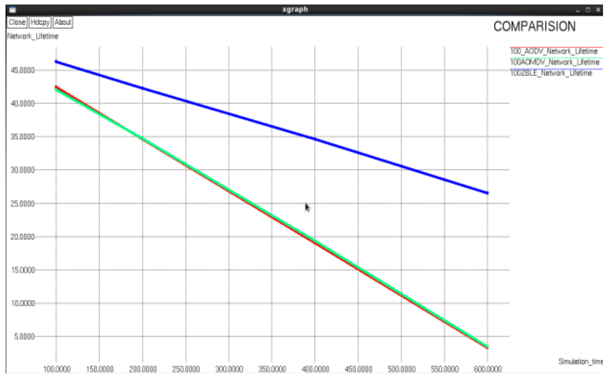

Fig.8. Network Lifetime comparisons

IX. CONCLUSION

Routing becomes challenging because MANET does not have any definite infrastructure. Efficient use of batteries is very important for increasing the life of the network. In this research, we have measured its capabilities applying an Energy-Efficient Zone-Based Leader Election Multipath Routing Protocol for MANETs named ZBLE. These scenarios have been expressed through several matrix throughputs, end-to-end-delay, Energy Consumption, and network lifetime. The effects of the simulations have determined that the proposed ZBLE performs well against existing protocols AOMDV and AODV.

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