Improving the Battery Life of Mobile Adhoc Networks through Quality of Service Parameters

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Abstract—**Because each node runs on its own node power, power management in a wireless network is a time-consuming procedure, especially in a Mobile Adhoc Network. The entire communication system breaks when the internal battery dies. Several ways are given to improve the performance of Mobile Adhoc Network (MANET) battery management, which might be utilized to evaluate MANET performance metrics. This article proposed new techniques for using internal node parameters and forming the cluster head node, a small change in MANET working principles called sleep and awake node management in MANET, choosing the best route for forwarding packets by one node among clustering to improve battery lifetime, which is accomplished through collaborative route management among the nodes. The NS-3 is used to simulate the suggested work, Forwarding Packet based on Wireless Parameter Adhoc On Demand Vector called FPWP-AODV, and the outcomes are compared with the current AODV protocol, for analyzing the power utilization, node connectivity, delay, node mobility, throughput, packet delivery ratio, end to end delay, energy consumed, cluster accuracy, cluster head life time, and network lifetime which offers better performance and maximizes battery life comparing with the existing Adhoc On Demand Vector (AODV) protocol from 60% to 75%. In feature this work could be carried out to compare with other kind of MANET protocol to produce the best protocol for proposed cluster head based energy optimization method.**

***Keywords*—Mobile Adhoc Network (MANET), sleep and awake, battery life time, route management, forwarded packet, cluster head**

I. Introduction

The usage of an internal battery is a crucial feature in guaranteeing reliable communication in a Mobile Adhoc Network (MANET), which is self-organized, has limited infrastructure, and is utilized for various applications that demand quick connectivity and has numerous characteristics [1]. If the battery fails when deploying the MANET in an emergency situation, such as disaster management, the entire communication may be lost. Effective power management strategies are essential to extend battery life. Several routing protocols have been proposed to address MANET challenges such as frequent topological changes caused by MANET characteristics, collisions caused by hidden and exposed terminal problems, failure in packet forwarding caused by internal threats or buffering capacity, all of which affect MANET Quality of Service (QoS) [2].

Traditional approaches to enhancing MANET battery performance begin with lowering gearbox power while also lowering energy utilization [3]. Packet route selection is part of power transfer. Topological ordering of MANET nodes is used to select routing. To handle battery power management, multiple MANET protocols and numerous new categories of routing protocols [4–6] are proposed. Several research articles have recently been published to improve the performance of the Adhoc On Demand Vector (AODV) protocol, including An optimized AODV [7], Stable Quality award Reliable AODV (SQ-RAODV) [8], Backup Routing Adhoc On Demand Vector (BR-AODV) [9], Reliable Delivery AODV (RD-AODV) [10], AODVusing Broad cast Routing Adhoc On Demand Vector (BR-AODV) [11], ad hoc on-demand multipath Routing with Lifetime Maximization AMOR-LM [12] Energy Aware Multipath AODV (EASM-AODV) [13], which are supports for increasing battery life. MANET parameters, such as minimizing MANET overhead to support better power management, are also regarded important factors in reducing battery power utilization; many optimization strategies are based on this.

Cluster node selection with Low Energy Adaptive Clustering Hierarchical (LEACH) protocol improves lifetime span with energy distribution [14], Fitness function incorporates in Fitness Function AOMDV

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(FFAOMDV) to reduce power consumed [15], AI neural network based MANET to optimize MANET energy usage, which supports network efficiency and overall performance [16]. GPS and long-range technology exhibited long-term MANET utilization after Receiving Signal Strength Indicator-based (RSSI) from the receiver strength [17]. To improve multipath rouging, EMBOA [18] blends butter fly optimization methods with a machine learning methodology that uses less energy. MANET security challenges, clustering method support to solve battery power issues [19]. As a means of addressing power constraints, nodes in a MANET PEO-AODV algorithm [20] supplied geographic position monitoring and calculated hop count parameters.

The LEACH protocol for cluster node selection extends the node's life span through energy distribution [14], while the FFAOMDV fitness function lowers power consumption [15], and artificial intelligence neural network-based MANET optimizes MANET energy usage to support network efficiency and overall performance [16]. GPS and long-range technologies have shown long-term MANET utilization upon getting Receiving Signal Strength Indicator-based (RSSI) from the receiver strength [17]. EMBOA [18] strengthens multipath routing by fusing machine learning techniques that use less energy with the fly optimization techniques. Threats to MANET security support for clustering algorithms to get around battery power problems [19]. The estimated hop count parameter and geographic position monitoring were provided by nodes in a MANET PEO-AODV algorithm [20] to help overcome power outages.

The structure of the article is as follows: Section II provides an overview of the different power optimization techniques that have been used in MANET up to this point. Section III suggests the principles behind how MANET operates. Section IV discusses the results and discussion of the research work. Section V concludes with feature work and a conclusion.

II. Related Research

The energy optimization strategy built into MANET technology simplifies the categorization parameter. The research work beginning is covered in literaturereview was carried out to understand the latest research work done it on MANET. This survey makes to improving further research in the battery power. Several group of research has done based on the factors of routing, mobility, clustering, hybrid approaches, and transmission range to improving the internal node battery power but some methods success in few aspects others fails in few aspects.

To begin with a literature survey to maximize battery life of the MANET nodes, a set of research groups conducted a study on movement awareness in MANET. LEA-AODV techniques with support for the load balancer and energy distribution approach were presented by Al-Gabri *et al.* [21]. It was also demonstrated that each transmitting node's residual energy improved but load balancing was the additional overhead to the nodes. In order to improve power optimization, Woungang [22] did research on Route Request (RREQ) modification in MANET Request (REQ) messages, sending only the reverse REQ to the required nodes that enable Energy Field but transmissions of these messages consumes some kind of transmission energy to gain energy optimization, Gu and Zhu [23] employ Route Energy Comprehensive Index techniques which required maintaining the nodes indexing. Li and Li [24] use Network Lifetime but prediction of this parameter was impossible. In order to attain maximum residual energy in MANET, Alghamdi [25] uses the LBMMRE-AOMDV methods of algorithm by permitting the RREQ approach for determining energy consumption while the RREQ messages floating consumes nodes internal energy.

In consequently the contribution of topological management to MANET energy conservation is the focus of another set of scholars. Using an Optimized Power Control approach in MANET protocols, Chaudhry and Tapaswi [26] had shown good results in transmission power, latency, and energy usage but failed on OPC-CC. For routing, Zhang *et al.* [27] developed a unique M_AODV protocol, showing that it decreased overhead and delay but were unable to overcome link breakdown. Although authors Rahmani *et al.* [28] suggested new topology and the simulation results provide metrics for self-awareness, self-adaptation, and self-adjustment, they are unable to create a routing topology for the network.

The Place of Residence (POR) technique for energy optimization was introduced by Sri *et al.* [29]. The simulation results showed that the technique could change the network capacity, but the network performance was super. The Secure Optimized Link State Routing Protocol for energy control was created by Singh *et al.* [30]. It allows for the simulation of a link and message without the need for a third party.However, they did not include attack detection for internal threats. The TESAODV protocol, according to Sridhar *et al.* [31], shortens the life span of network nodes but is not able to maintain energy levels. Rao and Singh [32] provide the KF-MAC (K-means cluster formation firefly cluster head selection based MAC routing) approach, which succeeds in QoS metrics but falls short in delay management.

A small group of authors created a series of techniques to aid in enhancing MANET's residual energy. A power optimization approach based on the Selfish Node Detection Algorithm (SNDA) technique was proposed by Musthafa *et al.* [33], although the results produced a dependable communication but fell short of security. A game theory-based model is used by Vij *et al.* [34] for energy optimization; in the simulation, all nodes reach their energy level, but with longer propagation latency and more overhead. For power optimization, Nobahary *et al.* [35] utilize the Credit-Based Method, which uses Generic Network Features but uses less energy. The Intrusion Detection System Monitoring (IDSM) strategy for energy reduction was developed by Veeraiah *et al.* [36]; while this approach increased Quality of Service performance, it fell short of meeting the overall performance standards. The NCV-AODV protocol is used by Abirami *et al.* [37] for MANET routing; it reduces neighbor credit cost while maintaining a high latency.

The Artificial Immune System is an artificial intelligence system used by Jim *et al.* [38] that increases packet loss while improving packet delivery. An energy-efficient method for reliable data transmission was presented by Ponnusamy *et al.* [39]. It provides better energy storage at the expense of increased overhead. The MSD-SNDT technique was developed by Ramesh *et al.* [40] for energy optimization; despite being carried out in vitality utilizations, the result is extremely low energy usage. A fuzzy-based technique known as the Fuzzy-Dependent SN Detection Method was presented by Hasani *et al.* [41]. In this method, all nodes are more active in communication, but the system costs more because of the reduced power usage. A game theory-based method was presented by Nobahary *et al.* [42], in which all nodes collaborate to play a repeated game, but the overall efficiency is not reached. AODV was used on a wireless network by Kumar *et al.* [43], which led to a reduced packet delivery ratio.

Set of researchers finds out a protocol based on cluster head forming can support the lifetime of MANET nodes. In comparison to other approaches, Kumar *et al.* [43] achieves faster throughput, reduced latency, lower jitter, and lower PDR by using the ORS methodology of Clustered Head Forming Technique. The HAMBOCHLD approach for energy optimization was developed by Venkatesh for MANET [44]. Simulation results indicate that energy waste decreased to the expected level. Given the HAODV cluster head protocol, Goyal *et al.* [45] showed an improvement in PDF, END, and routing overhead. The EECAO clustering model is applied by Kumar and Bala [46] for battery power analysis; however, the strategy causes the MANET nodes to have a long lifespan.

Although two cluster heads are needed, the cluster heads in sahu [47] produce Network Lifespan and Residual Energy when the researchers apply the ACO approach. PDR and NLT approaches are used by Al-Najjar [48] to create a uniform distribution of energy. Lastly, the C-SEWO innovation design was developed by Devika and Sudha [49] to create cluster head forms that facilitate more cutting-edge clustering head-based protocols.

Research on mobility aware based techniques and hybrid clustering may be able to improve the battery life of MANET nodes. To reduce route failure, Braik *et al.* [50] use the AGS-ROA mobility aware cluster technique. Hamad and Vigila [51] uses the cluster HPSO-GA methodology to enable node energy improvement, whereas Venkatasubramanian [52] implements the EPO-FGA method for mobile node lifetime. The EEMST approach is used by Hamza and Vigila [53] for energy optimization, yet the study revealed Sivapriya and Mohandas [54] discovered in Prolong the Lifespan that the MKMPE technique led to increased packet loss as opposed to optimization. In order to maximize MANET node power, Saravanan *et al.* [55] proposed an efficient clustering technique. In order to attain the goal of Reduced Consumption of Energy, writers Bisen *et al.* [56] proposed the E-MAVMMF approach. where as Arulprakash *et al.* [57] presented the EBDC technique, Lastly, in an effort to lower the amount of power used by internal batteries, research is concentrating on gearbox range in physical later supports. A few authors optimize the energy of MANET nodes by utilizing study work based on transmission range. Goldberg *et al.* [58] uses Dynamic and Adjustable techniques to make it easier to build MANETs at a minimal cost, with an ideal number of three neighbors for each node. Ansari [59] save a substantial amount of energy by using ATP-AODV, which lowers ATP latency. Equilibrium According to Ref. [60], the network uses metric norm during the routing process, yet the results indicate that the network's lifespan is increased. Jiao and Guo [61] used Minimum Hop Routing (MHR) and Minimum Total Power Routing (MTPR) strategies to loosen control.

Park [60] proposed using Hello Messages sent by Neighbor Nodes to improve network performance, but at the cost of introducing significant delay. Porto and Stojanovic [62] have recommended Energy Efficiency through Transmission Power Optimizationin order to maximize throughput. Wang *et al.* [63] established an Average Setting Time by determining the Optimal Transmission Radius for floods in large-scale networks. Several IoT related researches aids to improve performances of wireless [64–66].

The analysis of related work indicates that while all research projects focused on a single MANET domain such as routing, mobility, clustering, hybrid approaches, and transmission range achieved success, other approaches had unfavorable outcomes. Further investigation is needed to optimize power in MANETs. In order to achieve power optimization in MANET, this research study focuses on modifying internal node parameters and MANET functioning principles.

III. Proposed System Architecture

This study work's system model takes into account the following factors: changes in MANET operating principles and internal node settings. Internal node parameters cover things like beacon signal utilization, ideal node muting, and unnecessary packet forwarding. The Sleep and Awake protocols have changed the fundamentals of MANET operation.

The system model is initially created for the creation of internal node parameters. Fig. 1 depicts the total architecture. This discussed the process of building a cluster and communicating with other nodes,

Construct the MANET graph $MG = M, N$, where $M = \{m_1, m_2, ..., m_m, ..., m_n\}$ represents the total number of MANET nodes, $1 < m \leq n$ denotes the entire number of nodes, and $N = \{l_1, l_2, ..., l_v\}$ denotes the edges connecting the nodes. Assume S is the source, T is the targeted node, and H is the cluster head generated by forming a group of nodes in the region. The cluster head picked is based on the residual energy node, life duration, and connection connecting to the other nodes.

A. Selection of Cluster Head

Based on battery power, mobility, link life time, and node mobility, one of the nodes in each region will become the cluster head. A cluster node will have the highest value of node life duration, connectivity, and battery power and the lowest value of node mobility and distance.

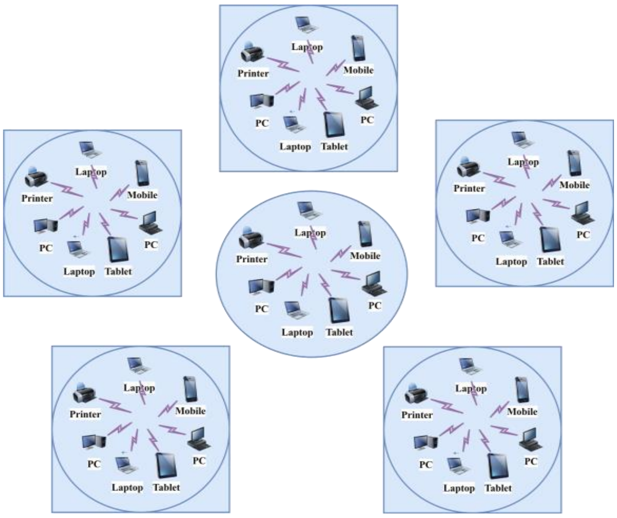

Fig. 1. System model.

For connecting two nodes and sending packets, the lifetime of each link is required. The link is utilized for packet transmission [61]. Because of changes in dynamic topologies, the link in MANET may disconnect, hence the life duration of the link should be determined in advance before picking the route. This could be calculated using Eq. (1) for computing energy model.

$$N_n = \frac{1}{f}\sum_1^g E_g \quad (1)$$

where g value is in the range from 1 to f, and E_g is the Energy Dissipation of g^{th} node.

Node Mobility: Mobility of the node is an important factor in MANET, which is computed using the Eq. (2).

$$N_m = \frac{1}{|P_h|}\sum B_g \quad (2)$$

$|p_h|$ is a Set of neighbor nodes, and B_g is a relative mobility.

Node Distance: Distance between the nodes used to estimate the link stability, which is evaluated using the formula in the Eq. (3).

$$R_n = \sum(U_g, P_h) \quad (3)$$

where P_h is set of neighbor nodes. U_g is the Energy of current nodes

Node Power: Node power is essential parameter in MANET, Highest node power node will be the cluster Head node which is estimated as using the formula from the Eq. (4).

$$p = \sum \frac{M_{Max} \times M_{Min}}{M_g} \quad (4)$$

n is total nodes where g value is between $1 < g < n$. $M_{\max}$ is the maximum power of the nodes. $M_{\min}$ represent the receiving power of the node. M_g is a g^{th} node receiving power

Connectivity: Creating bidirectional link between two nodes is called connectivity; which is computed using the formula of given Eq. (5).

$$C_h = \frac{1}{f}\sum_1^g \left(\frac{C_g}{e}\right) \quad (5)$$

where c_g is a g^{th} connectivity. e representtotal number of nodes connections

Cluster Head selection is based on collecting the MANET nodes, with device mobility, life time, distance, power, connectivity, and forming the cluster head is based on Algorithm 1, then the output of the set of nodes along with the cluster head will get as a processing output of the clustering head, as shown in Fig. 2.

Algorithm 1: Forming cluster head

1. Collect the total number of nodes in each MANET region
M = {R_1, R_2,R_3,..., R_n }
M MANET SET
R_1, R_2, R3 ...Rn-Regions where each region R_i having set of N number of nodes, among one node will be a cluster Head.
2. For each Region Ri, Do follows
for (I =1;i ≤ n ;i++)
{
• Gather all of the nodes' life time, mobility, distance, power, and connectivity.
• A cluster node will have the highest value of node life time, connectivity, and battery power and the lowest value of node mobility and distance.
}

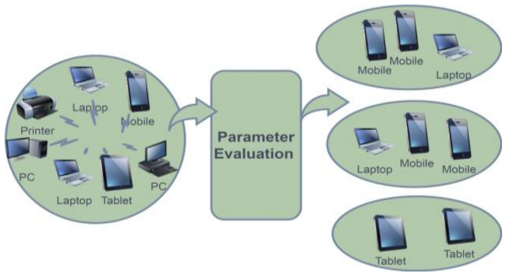

Fig. 2. Cluster node selections.

B. MANET Working Principles Changes using Sleep and Awake Strategy Routing Algorithm

This research paper modifies the MANET's working principles by introducing the sleep and awake MANET node stages, which are established by each cluster head after the cluster is formed. The route selection approach is also used by the cluster head in MANET routing tasks such as route request and route discovery. One of the new components of the new define algorithm is determining the device's remaining power for selecting the path from source to designate, and the nodes function in two modes: sleep and awake. The region nodes will specify this, with one node sleeping and the others awakening. Algorithm 2 defines stages of sleep and awake.

Algorithm 2: Sleep and awake node selection

1. Each node transmits a beacon signal to the other nodes in order to obtain the current location and battery power.
2. When other nodes receive the beacon signal, they communicate their present location.
3. Each node determines the nodes within the transmission range depending on their location.
4. Create a cluster of nodes in the same region.
5. Select the head nodes with the highest battery power in the same region.
6. The list of sleep nodes and awake nodes is defined by the head nodes.
7. Distribute information to other nodes in the region and begin the routing process.

The suggested algorithm's operation is depicted in Figs. 3–6 where a route Request is given from the source node to the destination node. As shown in Fig. 4, the route reply is transmitted by the destination node to the source node. Figs. 5 and 6 show the identification of many paths and the selection of the path with sufficient energy to transport the packet.

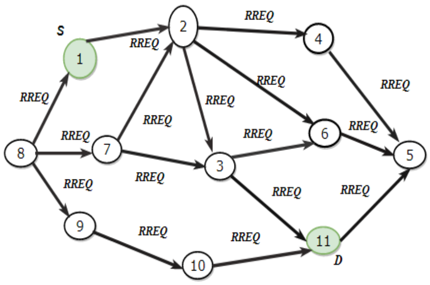

Fig. 3. Request route from source to destination node.

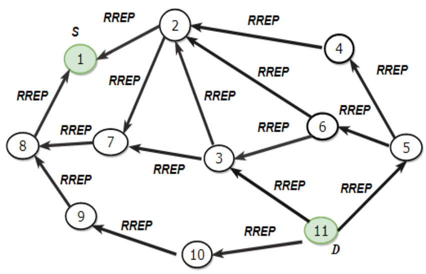

Fig. 4. Reply route from destination node to source node.

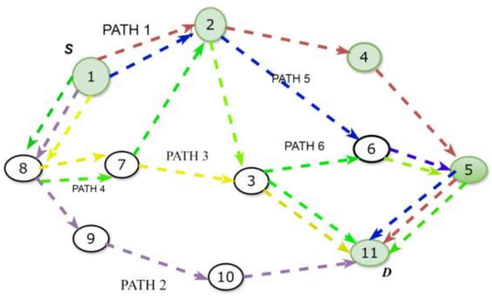

Fig. 5. Alternative path from the source node to destination node.

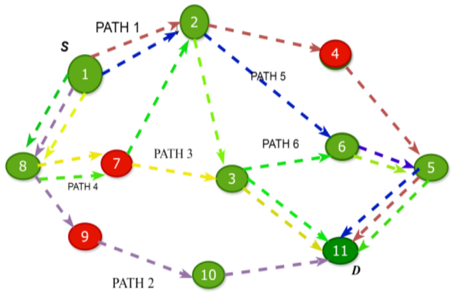

Fig. 6. Residual power on two different paths from the source to the destination.

IV. Outcome and Discussion

The Cluster head forming with sleep and awake routing strategy with sleep and awake node is implemented in Network Simulator NS 3.2 using a high-end system combination of Intel core CPU, 16 GB RAM, and Windows 10 operating system. Simulation Set Up is used to create the simulation results presented in Table I.

TABLE I. Simulation Parameter

Simulation Parameter	Value Set
MANET Network Interface	Wireless Physical Interface
Dimension	1500×1500 m^2
Antenna Defined	Omni Antenna
Number of nodes	50, 100, 150, 200
Link count	20–50
Source Transmission Type	Constant Bit Rate Transmission
Each Packet size	512 Bytes
Buffer Size	60 Packets
MAC Layer used	802.11 b
Simulation Defined Model	Random
Propagation model	2 Way Ground
Maximum node speed	30 m/s
Pause Time	30 s
Number of packet send between the interval	2 Packets
Time set for Simulation	50 s, 100 s
Initial node Energy	240 J
Each Node transmission power	0.9 J
Each Node receiving power	0.4 J
Sleep Power	0.002 J
Changeover Time	0.009 s

The on-demand routing feature of the AODV protocol is one of the reasons it was selected for comparison. In order tofacilitate comprehension, a comparison study is carried out utilizing the current AODV protocol along with additional parameters and a modified working routing theory that is integrated into AODV and called FPWP-AODV. The NS-3 is used to model cluster head formation, sleep and awake strategy implementation with simulation parameters described and listed in Table I are used.

In order to make the performance study the following factor are considered, power analysis which estimate the utilized power of each node during the operation, Delay analysis makes for finding the delay to compute the cluster head and forming the sleep node and awake node. Node connectivity analysis comparison was done for computing the reliability between the nodes while communication. To get clear understanding of cluster head cluster head life time, network lifetime and cluster accuracy comparison was made. To get the overall network performance the Packet Delivery Ratio, End to End Delay, Throughput comparison was done. Finally the residual energy for computing of power optimized done with the support of the energy consumed. All the factors are done by varying the nodes numbers from 50 to 200 by the increasing of 50 nodes in each 10 ms.

A. Power Analysis

A power analysis can be performed based on 50, 100, 150, or 200 nodes. The power of the proposed FPWP-AODV protocol is 21.03 J, while the regular AODV protocol's power is 19.02 J when the total number of nodes is set to 50. Subsequently, there is an increase in nodes from 50 to 100; the FPWP-AODV protocol power is 22.05 J, while the AODV protocol power is 19.0 1J. The FPWP-AODV protocol displays 25.03 J, while the AODV protocol displays 19.06 J when the number of nodes reaches 150. AODV poses 19.08 J when the node count reaches 200, whereas the FPWP-AODV protocol poses 26.07 J. Fig. 7 displays the comparison. From this results, conclude that the proposed FPWP-AODV outworks the best in 20% compared with AODV protocol also this proposed FPWP does not affect the nodes when overloaded.

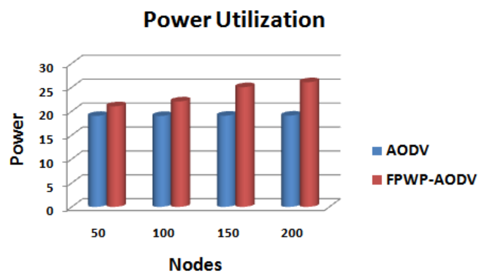

Fig. 7. Power analysis.

B. Delay Analysis

Additionally, to understand the cluster head forming the delay analysis is carried out for nodes between 50, 100, 150, and 200 nodes. The AODV protocol has a delay latency for forming the cluster head which consumes the power of 0.186 J when the total nodes are specified between 0 and 50, however the recommended FPWP-AODV protocol has a delay of 0.083 J. Subsequently, as the node count rises from 50 to 100, the FPWP-AODV protocol power is 0.65 J while the AODV protocol power is 1.01 J. The FPWP-AODV protocol displays 0.53 J, while the AODV protocol displays 1.06J when the number of nodes reaches 150. Ultimately, AODV poses 1.08 J while the FPWP-AODV protocol poses 0.77 J when the node count reaches 200. The delay is both a comparable and a reasonably acceptable delay as seen in Fig. 8.

C. Connectivity Analysis

As the number of nodes increases from 50, 100, 150, 200 the number of links connecting the nodes in the AODV and FPWP-AODV is compared. In the case of AODV and FPWP-AODV protocols, the connection link between nodes 0 and 50 is 8 and 12, respectively. In FPWP-AODV, the connectivity link causes the order to progressively increase when the nodes approach 100, 150, and 200. The links for FPWP-AODV and AODV are 26, 40, 50 and 16, 24, 32, respectively, which is depicted in Fig. 9.

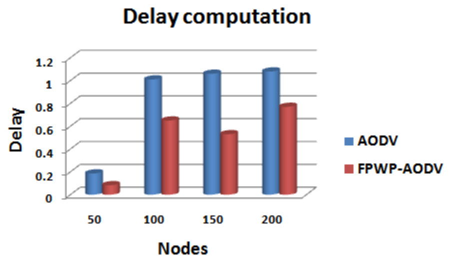

Fig. 8. Delay analysis.

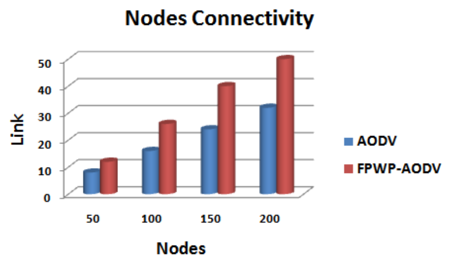

Fig. 9. Connectivity analysis.

D. Analysis about Node Mobility

Because of the characteristics of MANET devices, mobility is investigated to understand performance. The AODV and recommended FPWP-AODV mobility are 0.2, 0.25, 0.28, 0.29 and 0.1, 0.13, 0.15, 0.16, respectively, when the nodes are defined as 50, 100, 150, 200. The recommended limitations for the node mobility are shown in Fig. 10 and the results are slightly different. The results reveals that proposed nodes mobility not affect the cluster head forming.

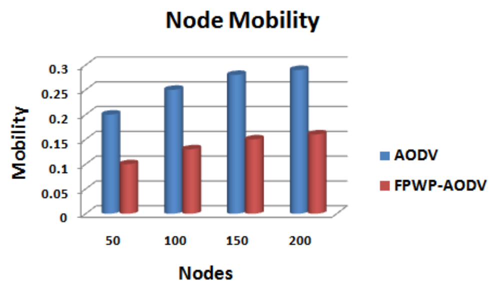

Fig. 10. Node mobility.

E. Throughput Analysis

The maximum number of packets received from the sender is known as throughput, and it may be computed using the formula below. A throughput analysis is carried out using 50, 100, 150, and 200 node counts. 180, 220, 222, 250 and 224, 269, 322, 365 Kbps are the throughputs for AODV and FPWP-AODV, respectively. The equation generated from Eqs. (6) and (7) is used to calculate the comparison shown in Fig. 11.The proposed FPWP AODV though put is 60% to 65% better than the current AODV throughput.

$$Throughput = \frac{\text{Packets}}{\text{Transmit}} \tag{6}$$

$$Transmission\ Time = \frac{\text{Packet Send}}{\text{Time}} \tag{7}$$

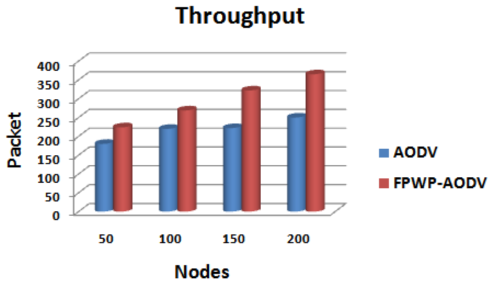

Fig. 11. Throughput.

F. End of End to Delay Analysis

Time is allocated by each node's operation for packet processing, transmission, and reception between nodes as shown in the Eq. (8).

$$EED = Packet\ Transmission + Packet\ Processing + Packet\ Delivery \tag{8}$$

Additionally, end-to-end delay analysis is carried out with 50, 100, 150, and 200 node counts. There are 20, 33, 37, 50 Ms for AODV and 18, 19, 32, 36 Ms for FPWP-AODV delays. Fig. 12 shows how the two are similar. The Results reveals that proposed FPWP-AODV work delay is less in 5% to 10% compared with the normal AODV protocol.

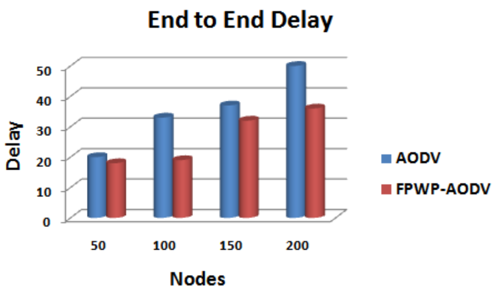

Fig. 12. End to end delay.

G. Packet Delivery Ratio

The packet delivery ratio is calculated using the equation of the number of packets sent by the sender and the number of packets received by the recipient based on the information in the trace file which is shown in Eq. (9).

$$PDR = \frac{\text{Receiving Packet}}{\text{Sending Packet}} \tag{9}$$

For packet delivery ratio analysis, the same technique is applied, with node counts varying from 50 to 100, 150, and 200. In percentage terms, the AODV and FPWP-AODV are 80%, 85%, 89%, 95% and 90%, 95%, 97%, 98%, respectively. Fig. 13 shows how the two are similar. Finally the proposed FPWP-AODV delivered more packets compared with AODV protocol in 20% to 30 %.

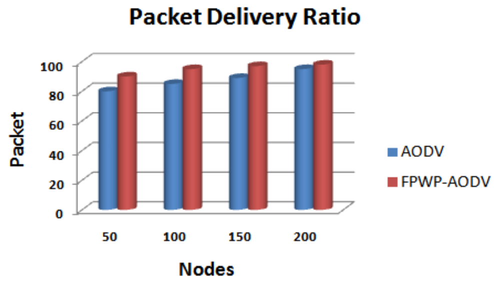

Fig. 13. Packet delivery ratio.

1) Energy consumed

The transmission Energy E_{Tra} and receiving Energy E_{Rec} is used to estimate node energy consumption which is computed from the Eq. (10).

$$E_{Con} = E_{Tra} + E_{Rec} \tag{10}$$

Using nodes 50, 100, 150, and 200, the total energy used for sending and receiving packets of a single route connection is compared to the AODV protocol, with values of 6, 12, 18, 24 J and 5, 9, 15, 20 J. As seen in Fig. 14, the suggested FPWP-AODV consumed less energy in 40% to 50 % comparison to the AODV.

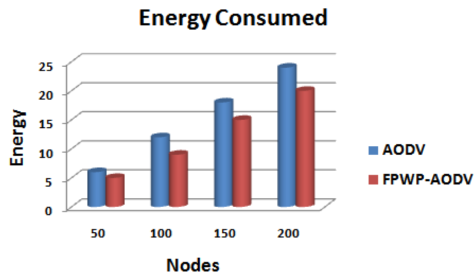

Fig. 14. Energy consumed.

2) Cluster accuracy

Verifying the simulation by varying the nodes to 50, 100, 150, and 200. While the recommended FPWP-AODV achieves 85%, 88%, 92%, and 98%, the current AODV protocol only achieves 75%, 80%, 87%, and 90%. As seen in Fig. 15, the suggested work performed best in terms of cluster accuracy.

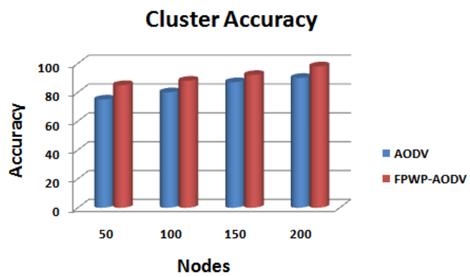

Fig. 15. Cluster accuracy.

3) Network lifetime

The equation generated from Eqs. (6) and (7) is used to calculate the comparison shown in Fig. 11. FPWP-AODV protocol nodes are relay on the all the packets transmission, which says all the nodes link time is excellent and improves the overall network life time.

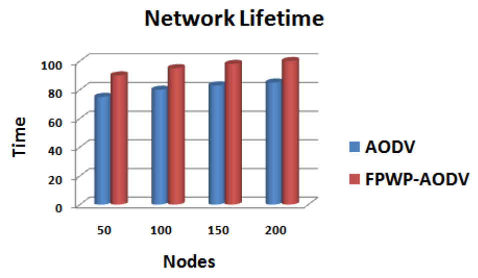

Fig. 16. Network lifetime.

4) Cluster head lifetime

The suggested technique showed a 35% improvement in lift time when comparing the life duration of cluster heads in MANET to the AODV protocol in Fig. 17. Cluster head lifetime is good and effective transmission of packets in the MANET nodes.

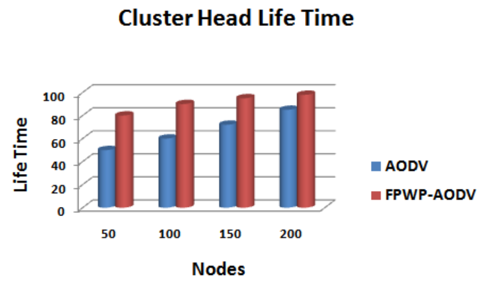

Fig. 17. Cluster head lifetime.

Finally, the FPWP-AODV performs good in all the aspect of performance factors of Packet Delivery ratio, End to end delay, Throughput, also the cluster head forming delay is manageable and the lifetime of the cluster head is good and energy consumed for making the cluster head is less and residual energy is high which support the lifetime of the MANET nodes.

V. Conclusion and Feature Work

This research article elaborates on maximizing battery power by constructing a cluster head among MANET nodes based on internal node parameters such as node battery power, link life time, node distance, and mobility. The cluster head is then in charge of determining the optimum routing path while also utilizing sleep and awake strategy formulation to optimize internal node energy. The NS-3 is used to simulate the proposed work, FPWP-AODV, and the results are compared to the current AODV protocol for analyzing power utilization, node connectivity, delay, node mobility, throughput, packet delivery ratio, end-to-end delay, energy consumed, cluster accuracy, cluster head life time, and network life time, which offers better performance and maximizes battery life compared to the existing AODV protocol by 60% to 75%. In particular, thisresearch work might be done to analyze other types of MANET protocols in order to find the optimum protocol for the suggested cluster head-based energy optimization approach.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

S. H. has pointed out the problem definition and simulation of the result; K. V. and G. N. contributed to the literature survey; N. M. P. and L. P. M. supported the research problem in the article; I. V. V. supported the graph from the simulation result. All authors had approved the final version.

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