A Certain Investigations on Energy Efficient Techniques on Wireless Sensor Networks over Smart Grid

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Abstract – Energy efficiency plays biggest role in the wireless sensor network as the sensors are smaller and restricted in their resource capacity. Due to their nature of restricted resource capacity, data transmission would become more complex. So, it is required to concentrate more on data transmission strategies, to ensure the interruption avoided data transmission. There are different examination strategies has been presented before for performing data transmission. Among them most of research methodologies focused on attaining energy consumption reduced optimal data transmission. The working principlee and processing flow of previous research methodologies has been discussed here in details. This survey article is to discuss the research techniques which attempts to perform energy consumption reduced data handling, so that network lifetime of various sensor nodes can be utilized effectively along with increased data transmission rate. And this research work discussed the merits and demerits analysed over each research techniques discussed here. Finally, this research work is concluded with the performance analysis over varying number of nodes. The examination of the analysis work is done in the matlab. The mathematical qualities have been examined to predict the exhibition level of various examination procedures as far as their packet transmission rate, delay and energy utilization.

Keywords – Packet Transmission Rate, Energy Consumption, End to End Delay, Reliable Data Transmission, Overhead.

I. INTRODUCTION

Wireless sensor network is characterizing collectively of sensor nodes which are circulated in the climate for detecting and dissecting the climate information [1]. WSN has been preferred and utilized in different environments such as military, agricultural, hospitals and so on [2]. This is most preferred due to its nature of independent and decentralized characteristics. As the sensor nodes are smaller in nature, capacity of them also limited to certain extends [3]. Sensor nodes with limited resource capacities cannot execute the tasks for long time which might lead to run time failure [4]. The main characteristics of sensor nodes which are limited in nature and have greater impact on data transmission are, “energy consumption, memory consumption, and bandwidth availability” [5].

The energy utilization is characterized as the all-out power consumed by the sensor nodes for the specific timeframe [6]. The remaining energy consumption is defined as the remaining power available in the sensor nodes after particular period of time [7]. Energy plays a greater impact on data transmission in wireless sensor network [8]. As the number of sensor nodes are increased in nature the data transmission rate also increased which required to spend more energy for reliable data transmission [9]. So, the energy factors need to be concentrated more at the time of data transmission.

WSN comprises of a greater number of nodes by using which different alternate route paths can be constructed to reach the destination node [10]. These nodes will transmit the volume of data to the destination nodes with the goal of reaching the maximum packet delivery ratio. In these cases, packet delivery ratio will get affected with reduced energy availability of

sensor nodes [11]. So, it is required to concentrate more on energy parameter while choosing the nodes for the data transmission.

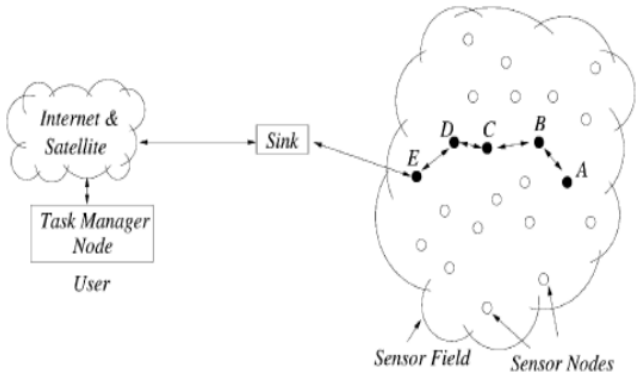

Fig 1. Architecture of Wireless Sensor Network [29, 30, 31]

There are different research methodologies have been introduced earlier for the energy efficient data transmission. Each research techniques focus on achieving energy efficient data transmission by following different procedure. Every method has its own processing method and processing flow. And, existing research methodologies varying in its characteristics in terms of merits and demerits.

The primary objective of this examination work is to analyze the handling stream of the current exploration strategies concerning their functioning methodology, handling stream, routing protocol, execution systems, etc. And afterward execution variety of the current techniques are dissected considering their benefits and negative marks. At last examination investigation of the exploration procedures are done considering mathematical upsides of every strategy observed from the simulation part of the examination paper.

II. DESIGN ISSUES OBSERVED IN ENERGY EFFICIENT ROUTING PROCESS

A sensor network configuration is impacted by many factors, for example, adaptation to non-critical failure, adaptability, power utilization [2]. These elements are significant on the grounds that they act as a rule to plan a convention or a calculation for sensor organizations. Based on these variables, different routing methods are analyzed, and their presentation is assessed [3]. Following are the significant plan issues looked while planning any routing conventions for remote sensor network framework.

Fault Tolerance

Adaptation to internal failure is characterized as the capacity to support sensor network usefulness with no interference because of sensor hub disappointments [34]. Senor hub might bomb because of the absence of force, actual harm, or ecological obstruction. The degree of adaptation to internal failure relies upon the utilization of sensor organization; henceforth the conventions are planned to remember the degree of adaptation to internal failure. The routing convention needs to such an extent that the disappointment of the specific hub doesn't influence the activity of the organization [5].

Scalability

The CH should have the choice to change in accordance with either addition or reduction in its cluster packets count [6]. The packet count of a cluster could change on account of various factors. For example, a packet part could tumble in view of normal peril. During this time the CH should change at a diminishing in its packet count. On the opposite side, extension in the part count may in like manner happen during conditions like development of new sensor centers, disillusionment of an ongoing CH, etc. Nearly the sensor network itself should be prepared for acclimating to either augmentation or decrease in the number of packs [7].

Energy Consumption

Since the life-season of the WSN relies upon energy assets and their utilization by sensors, the energy thought impacts course plan [8, 9]. The power consumed during transmission is the best part of energy utilization of any hub. Direct correspondence consumes more power than multi-bounce correspondence; but the multi-jump correspondence presents additional geography the board and medium access control. Substitution of the power assets is preposterous in certain applications consequently

energy utilization become significant as the sensor hub lifetime relies upon battery lifetime. Passing of sensor hub brings about changes in network geography and yet rerouting of the path.

Node Deployment

Node deployment ought to be conceivable through two unique ways: deterministic or randomized [1]. In deterministic game plan, the sensors are actually situated, and data is controlled through destined ways and in inconsistent center point sending, the sensor centers are disseminated with no obvious end goal in mind. The course assurance in the irregular created network is a difficult issue. Hub arrangement in WSNs is application subordinate. Contingent on the resultant hubs appropriation, ideal bunching conventions is expected to permit availability and energy proficient organization activity [2].

Data Delivery Models

There are three sort of information conveyance model: consistent, occasion driven, inquiry driven, or crossover [43]. Information conveyance models are application subordinate. In consistent information convey model, there is an intermittently conveyance of sense information by every sensor. Whenever the transmission of information started uniquely on the event of some occasion or question created by sink, such kind of model is called occasion driven and inquiry driven information conveyance models. Ceaseless, occasion driven, and question driven information conveyance models consolidated makes the half breed information conveyance model [4].

Data Aggregation

How much energy consumed in correspondence is exceptionally high than the energy consumed in detecting, subsequently to save energy the information is collected prior to sending it to base station [5, 6, 7]. Collection is expected to decrease the size of the information to be sent by amassing the comparative packets from the sensor hubs.

Network Dynamics

Most of the association plans expect that sensor nodes are fixed. In any case, transportability of both BS's or sensor center points is every so often key in various applications. Controlling messages from or to moving centers is more troublesome since course adequacy transforms into a critical issue, despite energy, information transmission, etc. Likewise, the distinguished quirk can be either strong or static depending upon the application, e.g., it is dynamic in an objective acknowledgment/following application, while it is static in forest checking for early fire aversion.

III. ANALYSIS OF ENERGY EFFICIENT DATA TRANSMISSION TECHNIQUES

In this segment, definite discussion of existing research techniques has been given considering their functioning method and handling stream.

The [4] performed correlation investigation of energy aware routing protocols presented before by different exploration creators. This exploration work gave the outline of elements which are the primary battles of guaranteeing the energy mindful routing in network layer. A portion of the variables that influence the energy effective routing are communicating nature of hubs, forwarding hub choice, course disclosure process, reroute revelation, and area of neighbour hubs. And furthermore, this examination work gave the conversation of different clustering-based routing protocols. Here correlation examination of different exploration methods has been done in the NS2.31 simulation climate with the presence of 500 number of hubs. This examination work inferred that the energy mindful directing should be possible effectively over the organization which used the grouping-based routing protocols and thinks about the energy utilization boundary. This examination work thought about the current strategies as far as different organization boundaries like throughput, energy utilization, number of sent bundles, and transmission time, etc.

In [5] introduced the Traffic and Energy Efficient Routing Algorithm (TEERA) with the goal of attaining the improved network lifetime. This research work also considered the traffic parameter for the reliable routing outcome where clustering process is carried out for the enhanced routing process. This research work improvised the routing process outcome by organizing the routing flow where the cluster head is chosen optimally through which reliable data transmission is performed. And also this research methodology is implemented in the heterogeneous network environment, so that this research technique can be applied on any real time environment. The constraints considered in this work for the efficient routing outcome are initial energy availability, residual energy and traffic load distributed among different cluster head nodes. Here examination of the exploration work is completed on the matlab from which it is demonstrated that the proposed technique achieves better execution as far as further developed network, energy utilization, data transfer capacity and traffic load the board.

The [6] proposed Cluster based Energy mindful Routing (CER) to improve the organization execution concerning network lifetime. The principal objective of this examination work is to ad lib the organization lifetime boundary, so continuous information transmission can be ensured. This research work adapted the clustering technique, so that organized handling of

data transmission can be guaranteed. This is done by introducing the hybrid methodology named as Hybrid Dolphin Echolocation and Crow Search Optimization algorithm by using which optimal cluster head selection is done. This research work improvises the performance by considering the multiple constraints at the time of selecting the optimal cluster head, so that optimal and reliable data handling can be ensured. The main parameter considered for the optimal cluster head selection is inter cluster head selection and intra cluster head selection. The general assessment of the examination work is done in the matlab re-enactment climate from which it is demonstrated that the proposed technique will in general have preferred execution over the current system regarding energy productivity, network lifetime, throughput and bundle conveyance proportion.

In [7] presented a Multi objective Fractional Particle Lion Algorithm (MOFPL) based ideal and energy mindful directing calculation for energy upgraded information transmission. The primary objective of this examination work is to pick the most ideal bunch head which can structure and put together the general organization handling stream. This calculation considered various requirements at the hour of bunch head choice, with the goal that ideal group head execution can be ensured. The imperatives that are considered in this examination work are delay, distance, energy level, thickness and traffic rate. The principal objective of proposed calculation is to track down ideal course way to guarantee the dependable information transmission. This ideal course way determination is guaranteed by picking the ideal group head hubs through which solid information transmission can be ensured. Here in the customary lion swarm calculation, execution is made do by coordinating the molecule swarm calculation to refresh the populace updation. The general examination of the exploration work is done in the Matlab R2015a device from which it is demonstrated that the proposed philosophy accomplishes further developed execution than the current examination strategies concerning further developed energy utilization, throughput and bundle conveyance proportion.

The [8] proposed Energy Efficient Mobility based Cluster Head Selection Method (EEMCHSM) for guaranteeing the better organization execution alongside expanded parcel conveyance proportion. This exploration system greaterly affects the energy use of the sensor hubs where there is no incorporated administration. This is settled by adjusting the grouping-based energy proficient routing protocol where ideal bunch head is picked before information transmission. The group head is picked in light of boundaries like data transfer capacity accessibility, energy utilization, etc. And furthermore, in this examination work versatility of hubs are considered for the ideal bunch head choice to guarantee the solid information transmission even with the presence of higher incessant hub development. And furthermore, with the presence of higher hub development, reclustering is done to guarantee the continuous information transmission. The general investigation of the exploration approach is done in the Matlab recreation climate from which it is demonstrated that the proposed technique accomplishes solid information transmission rate with lesser energy utilization.

In [19] performance energy efficient data transmission by introducing the method namely Machine Learning based Data Fusion Strategy (MLDFS). As the usage of network environment is increased, generation and sharing of data also increased considerably which might have more repeated information. Handling and transmission of more repeated information will lead to higher energy consumption and bandwidth consumption. This can be avoided by fusing the data's to be transmitted before data transmitted where repeated information will be avoided most. The main goal of this research work is to ensure the optimal data fusion outcome by adapting the machine learning based fusion strategy. In this research work extreme machine learning based Bat algorithm is introduced which attempts to find the repeated information by processing through multiple neuron layer. Once the repeated information is found, data fusion will be performed, so that redundant information transmission can be avoided. The proposed extreme machine learning bat algorithm is integrated with SEP clustering protocol to ensure the data transmission support in heterogeneous wireless network environment.

The [9] endeavored to perform energy effective information transmission by presenting the procedure in particular Hybrid Neural Network based Energy Efficient Routing Strategy (HNNEERS). As like other examination strategies, this strategy likewise adjusted the bunching procedure where the gathering of sensor hubs will be grouped together prior to playing out the information transmission. When the hubs are grouped, ideal bunch head choice is done to put together the general organization boundaries and to guarantee the ideal administration of sensor hubs. When the group heads are picked, visiting hubs will be chosen through which alone objective hubs can be reached. In this work weight positioning based ideal visiting hub is chosen. Here the limitations considered for the ideal visiting hub choice is number of information bundles communicated and jump distance. When the meeting hub is chosen, ideal course way will be developed by using the chose visiting hubs. The general assessment of the exploration work is done in the matlab recreation climate from which it is demonstrated that the proposed technique guarantees the ideal and energy productive routing.

In [10] endeavored to resolve the issue of force utilization issues by presenting the Energy concerned Routing Protocol (ERP). This examination work endeavored to present the strategy which can prompt the ideal and dependable steering with the worry of more energy accessibility. This is finished by presenting the strategy in particular Fish Swarm Optimization based Energy mindful Routing Protocol (FSO-ERP). The principal worry of this exploration work is to present the method that can guarantee the energy productive directing alongside expanded bundle conveyance rate. In this work FSA calculation is used for the ideal bunching and group head determination. In this exploration work every hub will be considered as fish

and the most ideal hub will be chosen as group head, with the goal that ideal information transmission can be ensured. The limitations considered for the ideal bunch head choice are remaining energy, intra group distance and entomb bunch distance. The general examination of the exploration work is executed in the OPNET 11.5 tool from which it is demonstrated that the proposed strategy accomplishes ideal execution concerning better energy effectiveness.

The [11] introduced the Visiting Node based Energy aware Routing Protocol (VNERP) which is an extended work of HNNEERS [20] where hybrid neural network is utilized for optimal visiting node election. In this work, optimal cluster head election is done by using Bald Eagle Search algorithm. Here cluster heads cannot be visited directly instead of it, the node can be visited only through the visitor nodes. The constraints considered for the optimal visiting node selection are hop distance, energy utilization rate, and hop distance. This research elected the optimal node by using group teaching algorithm. The group teaching algorithm is used to select the ideal cluster head through which reliable data transmission can be performed. The general investigation of the examination work is done in the matlab from which it is demonstrated that the proposed system achieves ideal organization execution which is superior to the current exploration procedure.

The [1] endeavored to perform energy-based routing in the remote sensor network climate by utilizing the Bivariate Regressed Adaptive Walds Boost Energy Aware Routing (BRAWBEAR). This research work aims to deliver the energy efficient data transmission for the real time users. This research work utilized adaptive walds boost ensemble technique to predict the weak learners from the group of sensor nodes. Here these weak learners are grouped and organized by using the regression tree. These regression tree will dynamically update the energy level value based on which error reduced accurate classification outcome. After analysing the energy level of weak learner nodes, optimal route path construction is done based on arrival time of data. The data packets will be transmitted through the selected route path with ensured lesser energy consumption and execution time. The general execution of this exploration work is done in the NS2.34 re-enactment climate from which it is demonstrated that the proposed technique accomplishes directing upward diminished information transmission with decreased start to finish delay.

In [2] presented the Advanced Panel Elevated Ensemble Dynamic Energy Mindful Routing Optimization (APEEDERO). The primary objective of this examination work is to present the procedure which can guarantee the ideal determination of course ways through which solid information transmission can be ensured. This examination work bunch the arrangement of sensor hubs at first, so that coordinated information transmission can be ensured. When the sensor hubs are bunched, ideal group head is picked through which information transmission will be done. Here group head determination is finished by zeroing in on requirements like energy utilization, data transfer capacity utilization, signal speed, etc. The general investigation of the examination work is done in the matlab re-enactment climate from which it is demonstrated that the proposed system accomplishes better information transmission rate with decreased energy utilization.

The [3] proposed a system to be specific ANT Particle Swarm Optimization Adhoc On-request Distance Vector (ANTPSDOAODV) convention. This exploration work guaranteed the ideal information transmission by thinking about the specific variables at the hour of ideal course way choice. The Quality-of-Service factors that are considered for the ideal course way choice are start to finish delay, throughput, parcel conveyance proportion, energy utilization, and directing upward over fluctuating qualities, for example, hub versatility, number of sensor hubs and information rate. This exploration work guaranteed the ideal information transmission rate The primary objective of this examination work is to guarantee the ideal information transmission alongside guaranteed QoS boundary values. The general evaluation of this examination work is done in the matlab re-enactment climate from which it is demonstrated that the proposed technique accomplishes dependable information transmission than the current procedures.

The [26] presented the Energy mindful Routing Approach (ERA) for ensuring expanded directing cycle result. The principal objective of this examination work is to guarantee the stable directing way development, with the goal that energy utilization decreased information transmission can be ensured. In this exploration work, hub accessibility will be checked once prior to building the course way, with the goal that information transmission interference can be stayed away from extensively. Subsequent to checking hub accessibility, the persistent and continuous information transmission is ensured by allotting the energy level of sensor hubs where hubs with lesser lingering energy will be kept away from at the hour of course way development. The general execution of the exploration work is done in the matlab re-enactment climate from which it is affirmed that the proposed approach accomplishes more prominent outcomes which is superior to the current examination system.

We have discussed limited number of research above. However, WSN tends to have different kinds of routing protocols which is shown in the following fi

IV. NUMERICAL ANALYSIS

In this research work, comparison evaluation of the existing research methodologies are done in the matlab simulation environment. The network parameters that are considered in this research work are shown in the following Table 1.

Table 1. Simulation Settings and Parameters

No. of Nodes	75
Area Size	1200×1200 m^2
Mac	802.15
Radio Range	200m
Simulation Time	100 sec
Traffic Source	CBR
Packet Size	512bytes
Mobility Model	Random Walk

The simulation deployment outcome which is done based on parameter values given in the **Table** 1 is shown in the following **Fig 3.**

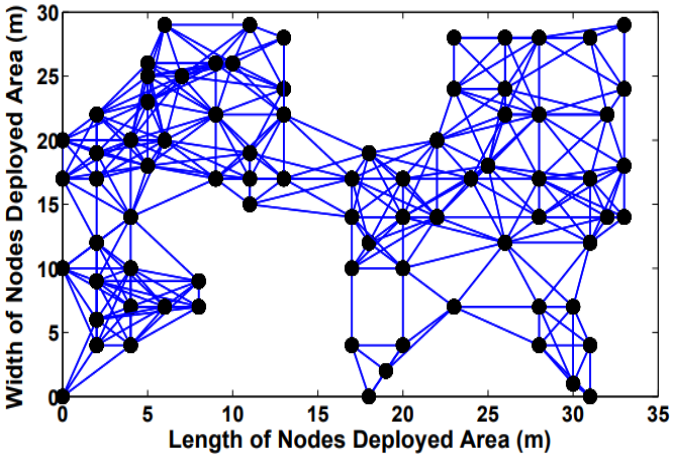

Fig 3. Deployment of Real Field Sensor Nodes Over the Area of 1200 X 1200m, Links are Shown in Blue Line and Black Dot is The Sensor Node

Table 2. Comparison of Protocols in terms of its Related Parameters

Protocol	**Latency in the sensor network**	**Mobility support**	**Cluster stability**	**Distributed cluster heads**
Light weight routing protocols	Low	Nil	N/A	N/A
LEACH protocol	Acceptable	Nil	Moderate	Moderate
AODV protocol	Higher	Nil	N/A	N/A
OLSR routing protocol	Acceptable	Nil	N/A	N/A
EEMCS protocol	Acceptable	Nil	Moderate	Moderate
SEP clustering protocol	Acceptable	Nil	Good	Good
HNN-GTOA protocol	Acceptable	Nil	Good	Good
ERA protocol	Acceptable	Nil	Moderate	Moderate
DSR protocol	Acceptable	Nil	Moderate	Moderate
ANTPSDOAODV protocol	Higher	Nil	Good	Good

The simulation parameters that are considered in this research work for the comparison evaluation are end to end delay, energy consumption and packet delivery ratio. Here comparison is made between the methodologies namely Traffic and Energy Efficient Routing Algorithm (TEERA) [2018], Multi objective Fractional Particle Lion Algorithm (MOFPL) [2019],

Energy Efficient Mobility based Cluster Head Selection Method (EEMCHSM) [2020], Visiting Node based Energy aware Routing Protocol (VNERP) [2021] and Energy aware Multipath Routing Technique (EMRT) [2022].

End-to-end delay

The typical time taken by a packet to send from source to objective across the organization is notable as End-to-End delay

$$\text{End to end delay} = \frac{\sum_{i=1}^{n}(t_{ri} - t_{si})}{n} \tag{1}$$

Where t_{ri} is the receive time of i-th packet, t_{si} is the sending time of i-th time and n is the total number of packets.

Table 3. End to End delay Simulation Values

Number of nodes	End to End delay metric values				
	TEERA	MOFPL	EEMCHSM	VNERP	EMRT
20	0.62	0.67	0.89	0.91	0.95
40	0.69	0.73	0.92	0.94	0.96
60	0.73	0.75	0.93	0.97	0.99
80	0.75	0.77	0.94	0.97	0.99
100	0.79	0.82	0.96	0.99	0.99

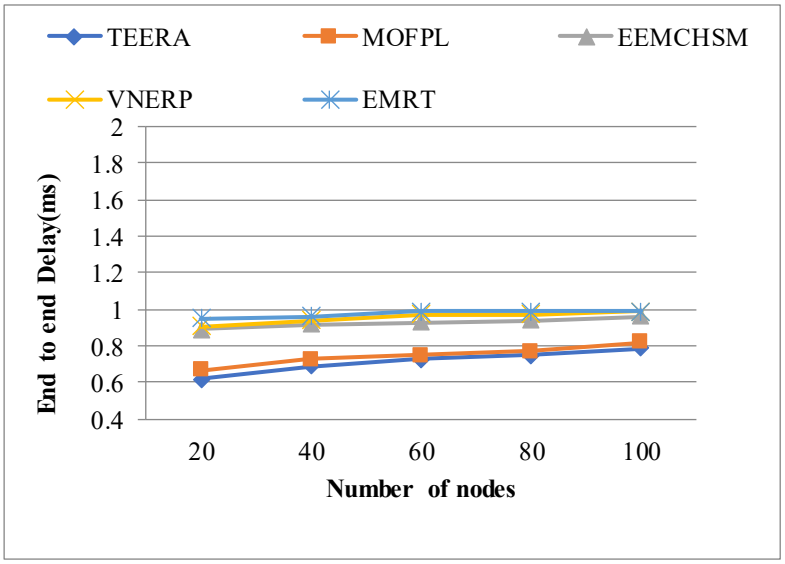

Fig 4. End-to-end Delay Comparison

Fig 4 outlines the examination between the current TEERA, MOFPL, EEMCHSM, VNERP, and EMRT procedures for the start to finish postponing execution. The hubs are fluctuated from 20 to 100 and the start to finish delay is plotted graphically for these hubs in milli seconds (ms). In the x hub, the quantity of hubs is thought of and the start to finish delay is taken in the y hub. The enhancement result shows that the EMRT calculation yields a lesser start to finish delay than the current TEERA, MOFPL, EEMCHSM, VNERP conventions. Hence the outcome demonstrates that the proposed framework has better execution as far as further developed energy utilization and organization lifetime with productive directing way utilizing EMRT conspire over given organization.

Energy Consumption

Energy utilization refers to the typical energy vital for sending, getting or sending tasks of a parcel to a hub in the organization during a timeframe

$$Energy\ (e) = [(2 * pi - 1)(e_t + e_r)d \tag{2}$$

Where pi is the data packet, e_t is the energy for transmission of packet i, e_r is the energy for receiving the packet i and d is the distance between transmission node and destination node.

Table 4. Energy Consumption Metric Values

Number of nodes	End to End delay metric values				
	TEERA	MOFPL	EEMCHSM	VNERP	EMRT
20	0.62	0.67	0.89	0.91	0.95
40	0.69	0.73	0.92	0.94	0.96
60	0.73	0.75	0.93	0.97	0.99
80	0.75	0.77	0.94	0.97	0.99
100	0.79	0.82	0.96	0.99	0.99

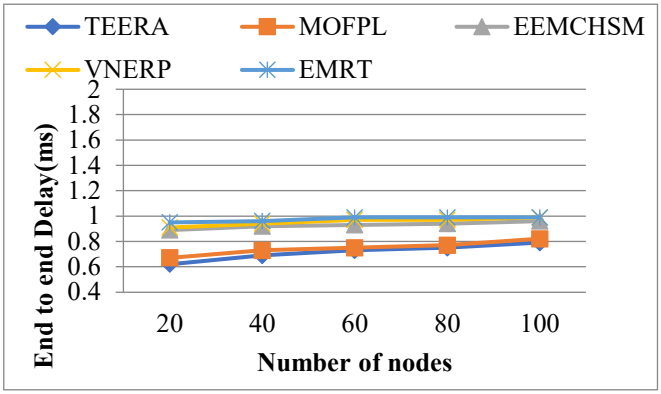

Fig 5. Energy Consumption Comparison

From the **Fig 5** it tends to be seen that the examination of energy utilization utilizing existing TEERA, MOFPL, EEMCHSM, VNERP, and EMRT approaches. The hub is plotted on x hub and the energy utilization is plotted on the y pivot. It shows that the current TEERA techniques give higher energy utilization while the EMRT give lower energy utilization. Hence the outcome demonstrates that the proposed framework has better execution as far as further developed energy utilization and organization lifetime with effective directing way utilizing EMRT conspire over given organization.

Packet Deliver Ratio (PDR)

This measurement is the proportion of the quantity of effectively conveyed information bundles to the sink over the all-out number of parcels produced by all sources. High level of the packet delivery proportion increments network dependability and fulfils the QoS.

Table 5. Packet Delivery Ratio Values

Number of nodes	Energy Consumption values				
	TEERA	MOFPL	EEMCHSM	VNERP	EMRT
20	26	20	15	12	9
40	27.6	23.55	17	15	12
60	28.5	25.66	19	16	12
80	29.99	27.34	21	18	14
100	31	29.65	23.5	19	15

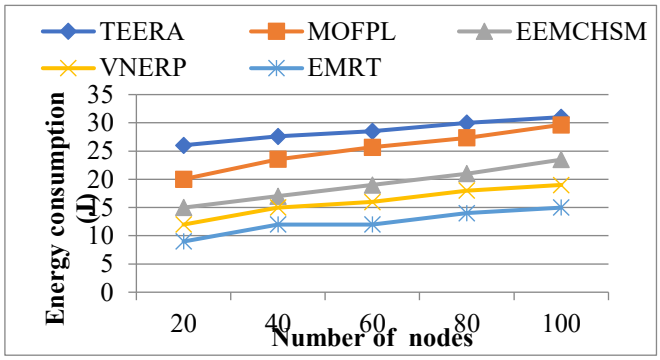

Fig 6. Packet Delivery Ratio Comparison

From the **Fig 6,** it very well may be seen that the examination of parcel conveyance proportion utilizing existing TEERA, MOFPL, EEMCHSM, VNERP, and EMRT approaches. The hub is plotted on x hub and the bundle conveyance proportion is plotted on the y hub. It shows that the current TEERA strategies give lower parcel conveyance proportion while the proposed EMRT give higher bundle conveyance proportion. Consequently, the outcome demonstrates that the proposed framework has better execution as far as further developed energy utilization and organization lifetime with productive steering way utilizing EMRT plot over given organization.

V. CONCLUSION

In this examination work correlation investigation of the different existing exploration strategies are given. This examination work gave the general investigation of different strategies as far as different boundaries such energy utilization, bundle conveyance proportion and start to finish delay is given. And furthermore, this examination work gave the correlation investigation of the exploration strategies as far as benefits and faults are given. The mathematical assessment of the examination work is additionally done here fully intent on anticipating the philosophy that can adapt to dynamic nature climate and furthermore guarantees the energy utilization decreased solid information transmission result.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author(s) declare(s) that they have no conflicts of interest

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