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Most Favourable Energy Extraction technique for relay node data transmission in WSN based IoT (Internet of Things)

Zubair Ahmed Khan[1], Apurv Verma[2]

[1]*M.tech. Scholar, Department of Computer science, MATS University, Raipur, Chhattisgarh, India.*
[2] *Assistant Professor, Department of Computer science, MATS University, Raipur, Chhattisgarh, India*

Abstract— The growing Internet of Things (IoT) is increasing Wireless Sensor Networks (WSNs) for different applications. Energy efficiency and reliability are key factors for the origin of multiple accesses to the sink. A forwarding node forwards data from other nodes to the receiver; therefore, it consumes more energy. When the repeated node runs out of battery, it can cause a network error in IoT based WSN. A selection of retransmissions in the transmission of more hops can play an important role in increasing the network life. Today, the IoT is more a descriptive term for a vision that everything should be connected to the Internet. The IoT will be crucial in the future because the concept opens up opportunities for new services and new innovations.

This paper proposes a new technique of Most Favourable Energy Extraction (MFEE), which would be the most appropriate for transmission nodes during the transmission of data between the sender node and the receiver in IOT based on WSN (Internet of Things). The MFEE technique will be implemented using the Network Simulator 2 simulation tool and compared with the existing distributed relay selection (EDRS) method. Performance evaluation of both the proposed method and the existing method is done, based on performance metrics of packet delivery ratio and total energy consumption and throughput. The results of the simulation showed that the proposed MFEE method exceeds the existing EDRS method in terms of total energy consumption with an improvement of about 35%.

Keywords*— *WSN, Internet of Things (IoT), Energy Efficiency, Network Simulator 2, Relay Node.

I. INTRODUCTION

The Internet of Things is based on the traditional telecommunication networks and other information carriers. IoT is an extension of the normal Internet. The Internet terminal is the computer (PC, server); they run all kinds of programs. Internet is nothing more like a data processing and transmission between computer and network. There is no other terminal (hardware) involved in the Internet.

The main idea for IoT is still the Internet. Unlike the Internet, there are not only PC and servers, but also there are embedded computer systems and its supporting sensors can be treating as terminals. It can connect all kind of independent objects and form them to function together, in order to achieve a functional interconnection network.

This is the inevitable result in our computer science and technology development. The computer has to serve human in variety of forms, such as environmental monitoring equipment, virtual reality equipment and so on. As long as there is hardware or products connect to the Internet, or the occurrence of data exchange, we call it "Internet of Things".

IoT has evolved commencing the convergence of wireless technologies, micro-electromechanical systems (MEMS), micro services and the internet technology. The convergence has assisted tear down the feed storage walls stuck between Operational Technology (OT) and Information Technology (IT), allowing shapeless machine-generated data to be analysed for insights that will constrain improvements.

II. RELATED WORK

In today's modern world, the human is dependent on digital devices because people have limited time, concentration, and accuracy. Therefore, getting meaningful and reliable information is a tough task. Automating basic functionality and gathering data without user interaction can save cost and improve the system performance. It would help when parts needed repairing, replacing, or recalling. With the emergence of new technologies, it is easy to design new devices that can be integrated into the IoT using WSNs. In this section, a literature survey regarding IoT and some energy efficient techniques developed for WSNs would be discussed.

Rahman et al. [1] have exhibited the vitality effective crisscross steering convention for WSN. In this investigation creator has gone through the issues of sensor hubs i.e. constrained power and built up a steering convention to improve the vitality utilization.

An exploration consideration was completed by Li et al. [2] on security systems for WSN. The creator has comprehensively clarified the different steering conventions and basically cantered on the SPIN steering convention. Creator has thought about the each steering convention by playing out the recreation over NS2 Simulator and through examination reasoned that the SPIN calculation is secure what's more, keeps up greater secrecy.

The consolidated investigation of Tarabovs and Zagursky [3] gave the effective correspondence reason medium access convention for grouped WSN. In WSN, the asset designation and vitality effectiveness is the testing issues as its SN have low power battery. Thus creator has displayed the bunch based MAC convention for WSN to bring productivity.

The low power versatile RP for WSN is displayed in Ji et al. [4]. To bring the vitality proficiency and resolve, the information conglomeration issue creator has exhibited the versatile steering calculation for grouping. In this grouping, head was chosen in view of hub thickness in the estimating region. The consequences of versatile steering calculation are contrasted and LEECH calculation and presumed that the calculation brings vitality enhancement and enhanced correspondence quality in conveyance circumstance.

Crafted by Hu and Li [5] introduced the geology locale based bunching calculation in WSN. In this, the each district picks its individual bunch head. To decrease the vitality use what's more, appropriate asset designation, multi-jump and single bounce blend is utilized. The recreation consequence of the geographic locale calculation fulfills the above necessity.

An instrument of load adjusts in WSN utilizing compressive detecting is depicted in Cao and Yu [6]. In this work the vitality utilization of SNs is considered. The heap is adjusted by utilizing compressive detecting, and the execution is assessed by Tiny OS and reproduction comes about speak to the critical outcomes.

The multipath steering for group tree WSN (ZigBee) was presented in Bidai et al. [7]. The examination is additionally worried about effectiveness, throughput and information transmission at low and high information rates.

Thaskani et al. [8] have presented a cross-layer plan convention for WSN to bring the vitality effectiveness utilizing token passing component. To beat the issues of conventional vitality productive WSN technique, the outline, and improvement layer of WSN is exhibited. The component gives effective comes about than some other directing components.

Othman et al. [9] have actualized the self stabilizing calculation to limit the vitality use in WSN. In this, the guess calculation is introduced to construct the spine for a sensor that brings the productive directing. The creator has accomplished the productivity in their strategy by re-enactment comes about.

Keeping in mind the end goal to adjust the heap in WSN, a multipath steering convention is displayed in Ming-hao et al. [10]. A heap adjust calculation is intended to adjust the system over the built up ways. The information parcels are conveyed over additional number of SNs and help in vitality improvement. The re-enactment is performed and contrasted the outcomes and a different steering convention. The system brings the vitality enhancement in WSN.

For the uneven hub sending of WSN, a bunching steering calculation is exhibited in Gu et al. [11]. In this, the detecting zone was isolated as different hubs and concentric annuli which are dispersed over uneven territory. The strategy results with better load adjusting system and vitality streamlining.

III. PROBLEM IDENTIFICATION

All The main concept of IoT is to interconnect digital devices, objects, people and physical entities that have a unique identifier and have the ability to transmit data through a network without human interaction [12,13]. IoT does not address a specific technology or application; It is a larger domain that can be used for a variety of applications. Recently, the IoT has received a wealth of health care, education and intelligent detection, in which intelligent objects interact with wireless sensors and collect data.

The IoT has evolved from wireless technologies, which can be used to automate different functionalities. In today's modern world, human beings depend on digital devices because people have limited time, concentration and precision [13]. Therefore, obtaining meaningful and reliable information is a difficult task. Automation of basic functionality and data collection without user interaction can save costs and improve system performance. It would be useful when the parts were to be repaired, replaced or removed.

With the emergence of new technologies, it is easy to design new devices that can be integrated into the IoT using WSN. This offers the opportunity to install intelligent and economical systems in cities and cities to solve common problems.

The success of IoT depends primarily on the reliability and energy efficiency of WSN [14]. WSNs are an important part of all applications, which have coordination between sensor nodes and the receiver. However, WSN and IoT have unique characteristics that represent a significant challenge for communication. One of the essential challenges is how to efficiently use node energy to maximize network performance.

In a multi-hop network, data is sent to the receiving node via a relay; therefore, the life of the network is based on the presence of the relay node. As a result, it is very important to adopt a viable energy strategy that extends network life in the multi-hop WSN. It is analysed that in some scenarios the retransmission mode is more efficient than direct transmission, especially when the source and destination channels are weak.

Multi-hop transmission is an important part of IoT WSN, how to collect data and transmit it to sink. Balancing energy consumption is a real challenge in IoT due to the limited resources of sensor nodes. The relay is an important resource in the network focused on multi-hop data, where data is collected from the sensor nodes and transmitted to a common receiver. Since hop-by-hop is transmitted in the data of multiple jumps, therefore, the life of the relay is very important for the performance of the network.

It is analysed that the consumption of emergency energy is very important for the entire network. Therefore, an energy-efficient retransmission selection technique for WSN IoTs is needed to improve system performance.

IV. PROPOSED RESERACH METHODOLOGY

The Internet of Things (IoT) is a concept that encompasses various objects and methods of communication to exchange information. Today IoT is more a descriptive term of a vision that everything should be connected to the internet. IoT will be fundamental in the future because the concept opens up opportunities for new services and new innovations.

The MFEE method is proposed in this research work keeping two research issues in mind; one is reliability factor and other is energy consumption. Both issues are boom in today’s era of wireless sensor network research. To work on in this method becomes more interesting since a new concept of IoT is been also studied. The MFEE method is the enhancement of the previous EDRS method including some more features on it, which was not included on the existing system in a multi-hop sensor networks.

In WSN, due to retransmission of data packets, the sensor node utilizes more energy than other normal nodes. If the node energy depleted faster, then the node will no longer available for compunction and cant acts as relay node or router. In such situation the lifetime of the sensor network would be affected. The MFEE method tries to resolve this issue by picking that node as relay node which has higher energy level and changes the position of relay node periodically. The reason to change the relay node periodically means, the relay node would be different when the sender node tries to retransmit the packet. This process is iterated for other relay nodes and appropriates other sensor nodes of the network.

Therefore the proposed technique of Most Favorable Energy Extraction (MFEE) would be more appropriate for transmission nodes during the transmission of data between the sender node and the receiver in IOT based on WSN (Internet of Things). The proposed method first collects information on the relay node and the distance of all relay nodes between the sending node and the receiving IOT sink node. Every time the sender wishes to communicate with the receiving node, the position of the relay nodes changes dynamically according to number of hop counts and packet sequence number. The relay node having least number of hops along with the earliest packet sequence number would be selected in order to forward the data towards the IOT sink node. The MFEE technique improves the way to select a higher energy level node between the relay nodes between the transmitter and the receiver so that the optimized path has high reliability and durability during data transmission.

The MFEE technique will be implemented using the Network Simulator 2 simulation tool and compared with the existing distributed relay selection (EDRS) method. The flowchart of proposed work is shown in figure 1.

The IoT based network scenario is designed using Network Simulator 2. The scenario is chosen in such a fashion that it should be multi-hop; it means there would be more than relay node or router in between sender node and IoT sink node. Whenever a sender node wants to send data, it checks for two conditions first.

If it is found that the recipient node is the IoT sink node, then sender node starts communicating without checking the relay node positions. This is reliability factor included in the MFEE method, since there is no need of searching for relay node and no need to waste the energy to find them.

If it is found that the recipient node is the IoT sink node, then sender node starts selecting different relay node as multi-hop scenario is picked up. The MFEE method checks the energy level of all relay nodes, and forwards the data appropriately by choosing high energy level of relay nodes. This step include one more step which is that the MFEE method also calculate the no. of hops required to reach at sink node , then the relay node which has minimal hop count is selected. Hence an optimized path is obtained which has higher level of energy and minimum hop count.

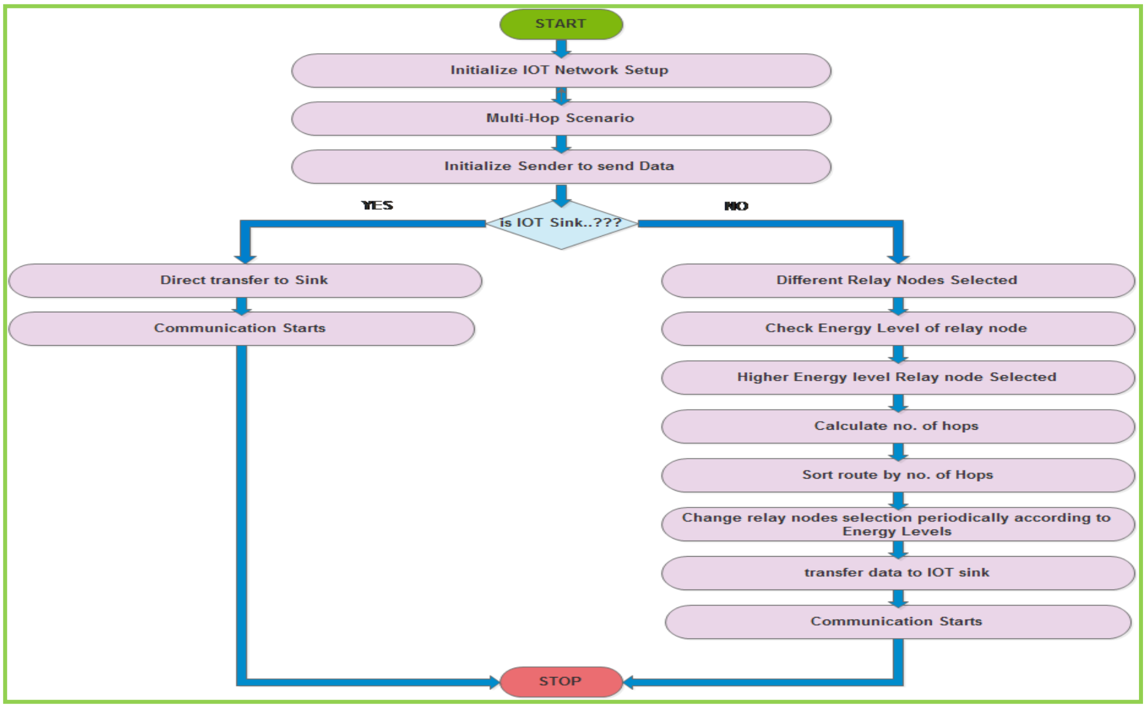


Figure 1: MFEE Methodology Flowchart

In addition, the selection of relay node is changed i.e. the same relay node is not available whenever the same sender node wants to retransmit the data towards the IoT sink node. The reason for this is that the different relay node utilized according to energy levels and the work load would not be increased on the relay node also, which saves energy for them. This process is iterated for other sender nodes also and the transferring of data started towards IoT sink node.

In overall, the MFEE method is very much enhanced in a way the existing system EDRS method selects the relay node. The existing system select the relay node based on relay node energy level, whereas the proposed method selects the relay node in reliable and energy efficient manner. The pseudo code algorithm for MFEE method is shown in figure 2.

```
INPUT: MFEE Method
OUTPUT: Min. Energy Consumption of Sensor Nodes
Step 1: Initiate all sensor nodes along with IOT Sink Node.
Step 2: IOT sink node sends Hello packets to all sensor nodes.
Step 3: Sender node receives hello request and do reply.
Step 4: Check whether it is IOT Sink Node...?
Step 5: If Yes;
          >>>direct transfer to IOT sink node.
          >>> communication started.
          >>> goto step 8.
Step 6: If No;
          >>> different relay node selected which forms minimal distance path to IOT sink.
          >>>Check Energy level of Relay Nodes.
          >>>Calculate no. of Hops and sort route by minimal hops.
          >>> Change relay nodes periodically according to Energy Level.
          >>> transfer data to IOT sink.
          >>> goto step 8.
Step 7:Communication started...
Step 8: Stop.
```

Figure 2: Pseudo code algorithm for MFEE Method

The performance metrics are used to quantitatively evaluate the energy efficient techniques. In this research after simulation, evaluation is done on the basis of following parameter.

V. PERFORMANCE PARAMETERS

A. *Throughput*

Throughput is one of the basic parameter which is considered for performance evaluation of the network. It is the average number of successfully delivered data packets on a network. In other words throughput describes as the total number of received packets at the destination out of total transmitted packets. Throughput is calculated in bytes/sec or a data packet per second, mathematically throughput is calculated as:

*Throughput (bytes/sec) = (Total no. of received packets at destination * packet size/ Total Simulation Time)*

The higher the Throughput metric is, the higher the value of received routing packets and the higher the efficiency of the protocol. So, the value of throughput should be high as much as possible.

B. *Packet Delivery Ratio (PDR)*

It is the output of total number of received packets divided by total number of sent packets, mathematically it is calculated as:

PDR= (No. of Received Data Packets) / (No. of Sent Data Packets)

The higher the PDR metric lead to the higher rate of dropping routing packets and consequently the lower the efficiency of the protocol.

C. *Energy Consumption*

Limited power supply is the biggest challenge of an Ad-hoc network so if we want to increase the network lifetime (time duration when the first node of the network runs out of energy) as well the node lifetime then we must have an efficient energy management protocol. Energy efficiency can be ensured by the duration of the time over which the network can maintain a certain performance level, which is called as the network lifetime. Routing with maximum lifetime balances all the routes and nodes globally so that the network maintains certain performance level for a longer time. Hence, energy efficiency is not only calculated by the power consumption but in more general it can be measured by the duration of time over which the network can maintain a certain performance level. The total energy consumed, includes the energy consumed by the control packets, to transport one kilobyte of data to its destination node.

Energy consumption of a node is mainly due to the transmission and the reception of data or controlling packets. To measure this amount of energy consumed during the transmission process (noted txEnergy), the transmission power is multiplied (txPower) by the time needed to transmit a packet:

TxEnergy = txPower x (packet size/bandwidth)

And for a received packet:

RxEnergy = rxPower x (packet size/bandwidth)

In a network, the total energy consumed:

Total Energy Consumed = (Initial energy – Energy left at each node)

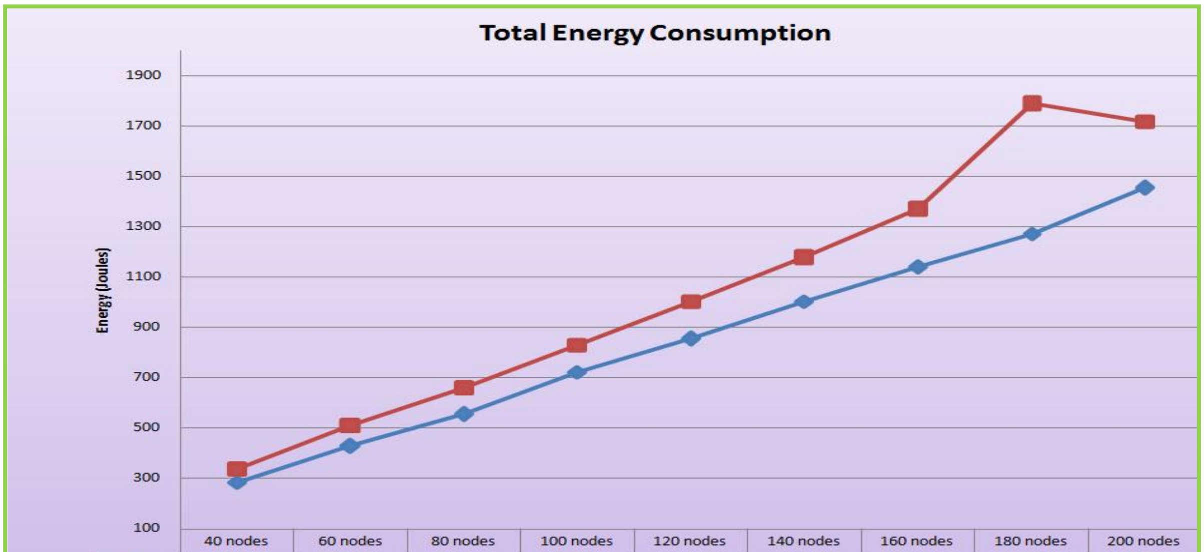
VI. SIMULATION SETUP & RESULTS

The goal of this research work to study the relative performance of selected energy efficient techniques named as MFEE and EDRS methods with respect to varying scenarios and traffic loads. Pre-generated scenario files are used to subject each method to the same set of scenarios and traffic loads in an identical fashion to perform a fair comparison. This chapter presents in detail about the performance metrics, Input and Output & its parametric evaluation and comparative analysis of existing and proposed methods.

Table 1: Simulation parameters setup

Parameters	Value
Simulator Version	Network Simulator 2.35
Mobility Model	Random Way-point
Performance Parameters	Total Energy Consumption, PDR, Throughput
Methods Analysed	EDRS and MFEE
Number of Nodes	40,60,80,100,120,140,160,180,200
Simulation Time	150 seconds
Traffic Type	CBR
Environment Area	1000 x 1000 meters square
Initial Energy	10.0 Joules
Transmission Energy	0.33 Joules
Idle Energy	0.10 Joules
Data packet Size	512 bytes
Transmission Range	250 meters

The below graph shows in figure 3 the total energy consumption of energy efficient techniques in which MFEE method achieves lower energy consumption while EDRS achieved higher value of energy consumption rate. The total energy consumption for MFEE method is 1446 Joules, and EDRS is 1717.58 Joules for 200 nodes. On comparing MFEE method particularly with EDRS method, the graph shows that MFEE performs better since it showed lower total energy consumption rate. MFEE method achieves 17.83% improvement in total energy consumption value than EDRS method.



	40 nodes	60 nodes	80 nodes	100 nodes	120 nodes	140 nodes	160 nodes	180 nodes	200 nodes
MFEE	285.45	430.79	557.17	723.19	857	1003.27	1138.77	1272	1456
EDRS	336.95	509.34	660	831	1003.86	1179.39	1370.99	1790	1717.58

Figure 3: Total Energy Consumption

The below graph in figure 4 shows the throughput of routing protocols in energy efficient techniques in which MFEE method achieves higher throughput while EDRS achieved lower value of throughput. The throughput value for MFEE method is 5791 kbps, and EDRS is 5513 kbps. On comparing MFEE method particularly with EDRS method, the graph shows that MFEE performs better since it showed higher throughput value. MFEE method achieves 4.57% improvement in throughput value than EDRS protocol.

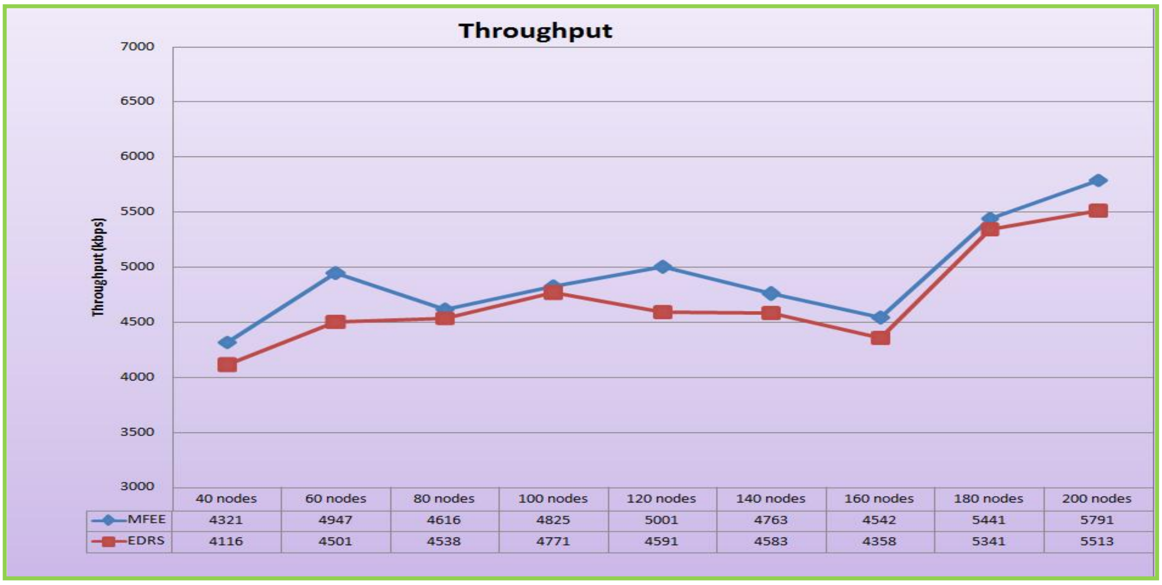


Figure 4: Throughput

Figure 5 shows the graph of Packet Delivery Ratio. The Graph clearly shows a decrease in percentage of packet delivery ratio in case of both MFEE and EDRS methods. It is decreased because the no. of nodes increased over the network and there is much more nodes are sent with RREQ messages to find the required destination node as the route is captured due to congestion in the network. Hence, graph shows that MFEE method performs well under all scenarios compared to EDRS method. The MFEE method showed 4.27% improvement than EDRS method.

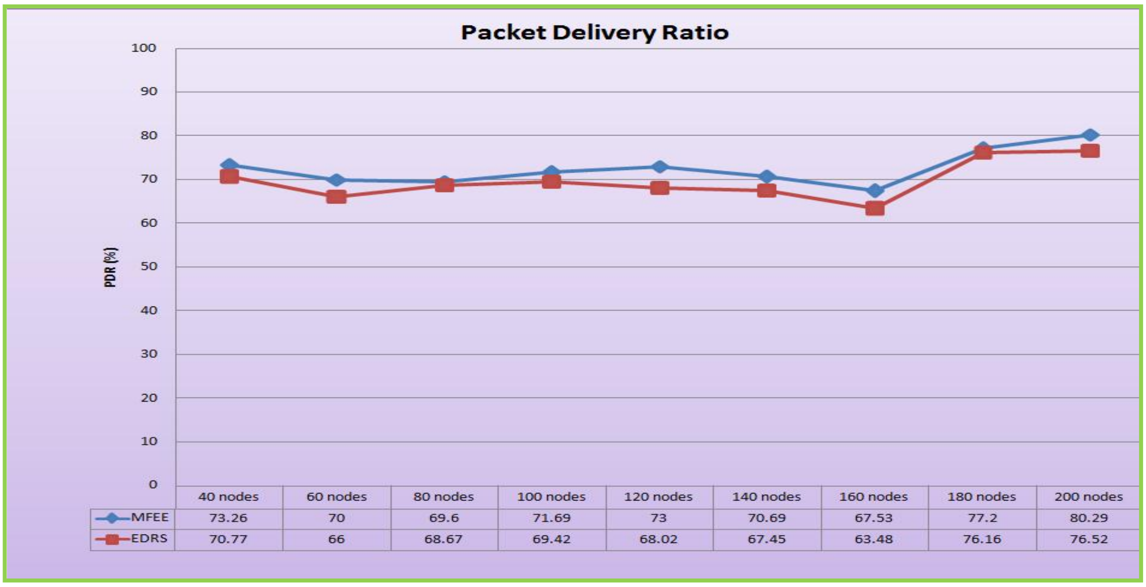


Figure 5: Packet Delivery Ratio

VII. CONCLUSION & FUTURE WORK

In this experiment, two set of energy efficient techniques for Wireless Sensor Networks based on internet of things (IoT) is analysed. Two methods are considered namely MFEE and EDRS energy efficient methods.

The MFEE method is proposed in this research work keeping two research issues in mind; one is reliability factor and other is energy consumption. Both issues are boom in today's era of wireless sensor network research. To work on in this method becomes more interesting since a new concept of IoT is been also studied. The MFEE method is the enhancement of the previous EDRS method including some more features on it, which was not included on the existing system in a multi-hop sensor networks.

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Both two methods are simulated using simulation tool NS-2. The MFEE method outperforms than the existing EDRS method. The percentage of improvement of proposed work is shown in table 2

.

Table 2: Percentage of Improvement

Parameter	EDRS Method	MFEE Method	Percentage of Improvement
Total Energy Consumption	1044.34 joules	858.18 joules	**17.83 %**
Throughput	4701.33 kbps	4916.33 kbps	**4.57 %**
Packet Delivery Ratio	69.61 %	72.58 %	**4.27 %**

The future work relies on improving MFEE method in terms of Quality of Service (QoS) and security feature. It would be tested for larger number of nodes deployed against different simulation area.

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