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Development of a Novel Protocol for Improvement of Qos Inwireless Sensor Networks: P-Rpeh

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Abstract: ***The Wireless Sensor Networks (WSN) plays an important function in wireless communication because of its top notch utility and benefits. Wireless Sensor Networks have thousands or hundreds of potential nodes, which are minute computer like, and areable of measuring the physical characteristics of the neighboring environment location and thentransmit the gathered information using wireless radio links. This paper proposes an efficient scheme for resource allocation used for the transmission of data using priority in the nodes. The protocol, Medium Access Control (MAC) has been devisedfor evaluating the performance. The parameters considered are bandwidth, energy consumption, delay, throughput andpacket delivery ratio. A new MAC protocol,"P-RPEH"(Priority that is based on the Residual Power and Energy Harvesting rate), using priority in nodes with maximumenergyis proposed. The proposed method is compared with the PRIN (Priority in Node) and PRIMA (Priority based MAC)existing protocols. The results obtained from the new protocol proves that, the newproposed protocoloutperforms the existingmethods in terms of bandwidth, delay, energy, throughput and the ratio of packets delivered.***

Index Terms: ***Wireless Sensor Networks,* QOS, Medium Access Control, Priority.**

I. INTRODUCTION

The Wireless Sensor Networks (WSNs) has enormous number of sensors which are distributedin a random manner. These small/tiny sensor nodes are made up of a sensor unit, a processor, a power unit and communication capacities. These effective nodes makecommunication with each and every other nodeand are successfulinsharing and transmitting the sensed parameters such as humidity,temperature, motion detection etc. The communication reaches the collectingstation at once or through different intermediate nodes. The Quality of Service (QOS) which is important in the Wireless Sensor Networks is dependent on many parameters. Some of the parameters considered in proposed work to increase the efficiency are as follows:

- **i.** Bandwidth
- **ii.** Energy Consumption
- **iii.** Delay
- **iv.** Throughput
- **v.** Packet Delivery Ratio

Bandwidth and Energy efficient routing protocols are required for obtaining the QOS.Further, there is a requirement for the standardized protocolin order to obtainthe information which is required by the sensors and are normallyavailable in the equipment of networking [1]. Prioritizing the nodes help in increasing the network performance which in-turn improves bandwidth andenergyefficiency.

Another parameter of importance is delay. In the process of collection of information, huge data statistics requirementshas to be gathered and accumulatedintime.Accumulatingrequired amount of data resultsina delay which may becomelonger. In this process, because of theinherent quality of the hyperlink used for the wireless transmission, thepackets which holds theinformation may get lost. This leads to a greater challenge in the transmission of real-time data, within therequired time frame.Some industrial applications allow delay-tolerance withinaspecifiedtime constraint [2].

If the packets are misplaced, the data has to be retransmitted again, which leads to a protracted postponement. In some situations such as monitoring, a long put off will delay the timing of obtaining data which causes extra losses. It is also crucial that a device makes a decision before the records are complete. This results in lack of information in some portions of the data.So care must be taken in such a manner that less delay is obtained. [3].

The other important evaluation parameters include the throughput and packet delivery ratio. There are numerous researches going on for the standardization of these factors to improve the QOS.

The QOS challenges differ in different WSNs with respect to resource constraints such as node deployment, real time traffic, scalability, data redundancy, topology changes, and contention window size so on.

The paper is arranged into 5 sections: in which Section 1 introduces the parameters considered for QOS. Section 2 discusses on the prior art in MAC protocols. Section 3throws light on the proposed method *P-RPEH* protocol.Theresults of the proposed methodology are discussed in section 4.The summary/conclusion of the present work and future enhancements are discussed in section 5 and 6.

II. RELATED WORK

From the survey of literature which ambitions to explore on the different types of MAC protocols that are used in WSNs to achieve better bandwidth and energy efficiency with respect to priority based allocation for QOS. Time Division Multiple Access (TDMA) and Carrier Sense Multiple Access (CSMA) are the different types of MAC protocols that are usually used for transmission ofdata through the wireless networks.

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PRIN based MAC protocol is one of the existing methods to improve the QOS. The PRIN uses static priority in source as well asin the intermediate nodes.AnandaKumarSubbramanya et al have assigned the highest priority to that node which maybeonly one hop away from sink node which aims to achieve a very good QOS parameters[4].
The amount of energy that is consumed is reducedby assigning differentpriority to all the incoming packets.
This hasincreasedthethroughput to some extent only.

Another methodisPRIMA, which is based on two phases. In the phase one, clusters are formed and in the phase two the channel is accessed. The clustering technique is used in MACto handle the issues related to network scalability in a better fashion.Jalel Ben-Othman et al [5], have used PRIMA protocol where in the channel access composes of the hybrid method where both TDMA and CSMA are used. TDMA controls the data and CSMA communicates with control messages. Thishas minimized the packet collision which the author claims to have reduced the energy consumption.

AQ-MAC is another Asynchronous MAC protocolwhich is usedfor obtaining the QOS inthe sensor networks, the efficiency of energyis obtainedby organizingthe incoming data into numerous static priorities.Fafoutis, Xetal[9], have discussed in detail the AQ-MAC protocol. The authors were able to moderately improve energy efficiency.

Bandwidth plays an important role in achieving good QOS. Bandwidth reduces congestion by assigning priority to the nodes. This is done using cluster formation. In the cluster formation process, the highest priority is assigned to theheadof clusters.The members of thecluster and the cluster head nodes communicate with single hop step, while the cluster head and the sink communicates with multiple hops. The data is sent using TDMA time slots inorder to utilize the bandwidth efficiently. [6]

D Mathavanet al have worked on the density of traffic. They have obtained a better bandwidth performance by creating adefinedpath tree. The path was based on the density of traffic. They have also separated the highest priority from the lowest priority in the tree. The author's claim that by doing so congestion can be avoided [7].

To identify the class traffic,SSridevietal [10], have usedEWMAmethod.Inthis method, traffic classifier is inserted into the appropriate queue depending on the traffic. Then Priority is assigned to each queue. Depending on the priority the packets are scheduled. High and low priority is assigned depending on the source and transit traffic. The authors claim that by doing so, more bandwidth has been used.

Timeliness and also reliability has a greater impact on the performance of QOS. To obtain the timeliness of the data the delay during the transmission over the wireless network should be less which also yields efficient transmission [11].

III. PROPOSED METHOD

WSNs have wide applications which include homeautomation, defense, health, environment and many other areas. To work in all these complex fields a good augment support system is required. To fulfill the WSNs capacity, QOS requirements must be enhanced. This can be achievedbysetting priorities in the existing MAC protocols.

In the present work P-RPEH has been developed to enhance the QOS. In this method, the minimum and maximum nodes taken are 25 and 125 and are presented in the figures 1 and 2 respectively. The proposed methodology is presented in figure 3.All the mobile nodes deployed are in random fashion in the real time environment.The routing protocol used for implementation is Ad-Hoc On-Demand Distance Vector (AODV). The other protocols which are generally used for routing have energy constrains and flooding, which is overcome by using AODV. AODV establishes routes to destination on demand.

Then the priority to the nodes is assigned depending on the maximum Residual Power and Energy Harvesting rate.If in case the residual power is large and the rate of energy harvesting is small, then the priority is not assigned to the node. Or with small residual power and large energy harvesting rate, the priority is still not assigned. The priority is assignedonly when both residual power and energy-harvesting rate is maximum.
The other nodes which lack these criteria go to the sleep state. For transmission of data through wireless network TDMA is used .

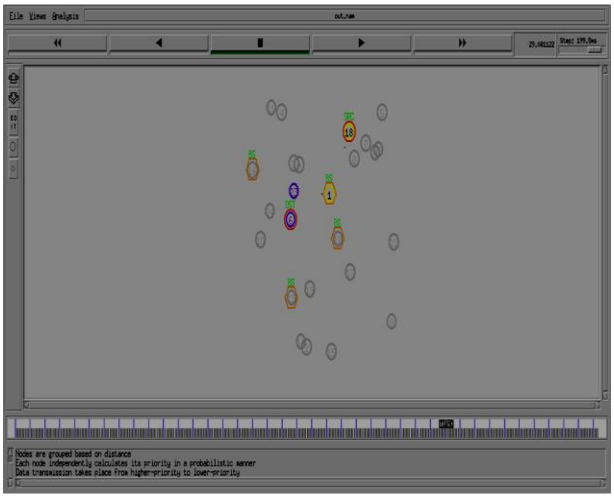


Fig 1: WSN Structure with minimum 25 nodes

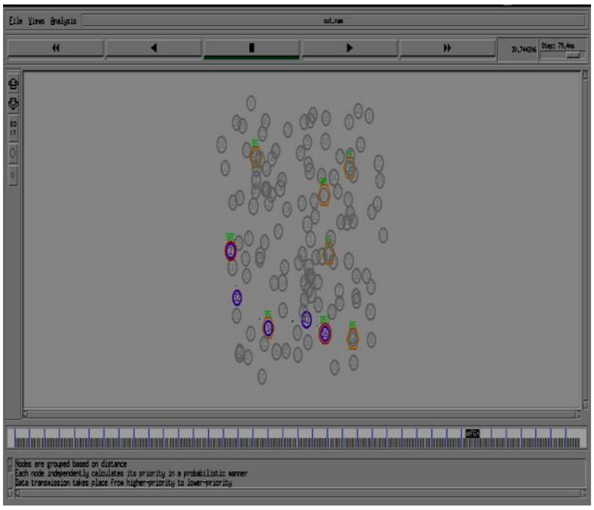


Fig 2: WSN Structure with maximum 125 nodes

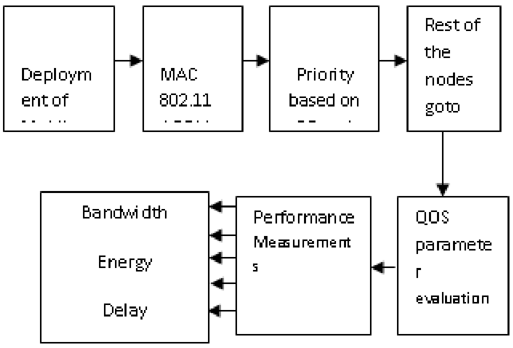


Figure 3: Proposed Methodology

The QOS performance parameters which are considered for the evaluation is listed below:

3.1 Bandwidth :

Bandwidth is calculated based on the RREQ (Route Request)Packets. These packets arethen sent to the destination node. These RREQ packets by the total amount of simulation time in the network, is expressed in equation (1) which denotes allocation of bandwidth.The source node at the initial stage checks theavailability of bandwidth. The RREQ packet is sent by the source if there exist a minimumof one time slot that is free at that instant of time, then the source sends a RREQ packet. If there isresponse within a fixed time period, then thenode which is the source node again sends the RREQ packet. If in case the response packet (RREP) is received, the path is set up for transmission. Once the path is set,the source node is responsible for allocating the time slots for starting thetransmission. During the process of path set up if there are three consecutive failures in finding thepath between source and destination, the source node aborts itself in sending the RREQ packets.

$$Bandwidth = \frac{B}{N} \quad \ldots\ldots.. (1)$$

Where Bdenotes the RREQ Packets sent to the destination nodein kbpsand$N$ is the total simulation time in seconds.

3.2 Energy Consumption:

If there are more number of nodes,the energy consumption is also more. A node drops some amount of energy for every packet transmitted orreceived, which is presented in equation(2)

$$Energy = \frac{E}{N} \ldots\ldots\ldots (2)$$

Where E is the amount of energy drop in joulesforthe transmission of each packet and N is the total simulation time in seconds.

3.3 Delay:

Delay is computed by the formula presented in equation 3, delay is nothing but the time that is taken by each packet hop from the sender to the receiver node.

$$Delay = \sum_1^n \quad Time\ spent\ on\ each\ Hop \ldots (3)$$

n = number of hops.

The unit for delay measurement is in seconds.

3.4 Throughput:

Throughput is computedas the number of total packets that are received by the destination node tothe total value of network time, aspresented in equation (4).

$$Throughput = \frac{T}{N} \ldots\ldots\ldots\ldots (4)$$

Where T is total number of received packets at the destination node. N is the total simulation time in seconds. It is measured in kilo bytes per second.

3.5 Packet Delivery Ratio:

The packet delivery ratio is calculated based on the number of packets that are actually sent from the source node to the number of packets that are received by the destination node. Equation (5) presents the same.

$$\text{Packet Delivery Ratio} = \frac{S}{W} \times 100\ldots. (5)$$

S: The number of packets which are sent by the source node
W: Thenumber of packets that are received by the destination node.

It is obtained in terms of percentage.

The simulation procedure used for the proposed scheme:

Begin
1. Spread out all the nodes randomly in the real time environment.
2. Apply AODV routing Algorithm
3. Then apply the concept of priority to nodes.The priority is assigned based on P-RPEH method.
4. The remaining nodes goes to sleep state.
5. Evaluate the QOS performance parameters.
6. Generate the graphs respectively.

End

Following the above procedure, the QOS graphs were generated. The parameters used for simulation are indicated in the Table 1

Routing algorithm	AODV
Priority based on	Residual Power +Energy Harvesting Rate
Simulator used	NS2
Simulation start time	0.000000000 sec
Simulation End time	50.00000000 sec
Random Mobility Model	Random Way point
Propagation Model	Two-ray Ground
Traffic Model	Constant bit Rate (CBR)

Number of mobile nodes (Fixed Nodes)	25, 50, 75, 100 and 125
Channel Model	Omni Antenna
Packet Size	512
Network Interface types	Wireless ad-hoc
MAC Type	MAC/802_11, TDMA
Performance parameters	Bandwidth by RREQ packets, Delay, Energy Consumption and Throughput

Table 1

IV. SIMULATION RESULTS

Here in section four the simulation results are discussed. The PRIN MAC and PRIMA Protocols were compared with P-RPEH, the present work.

The parametersconsidered for comparison are:

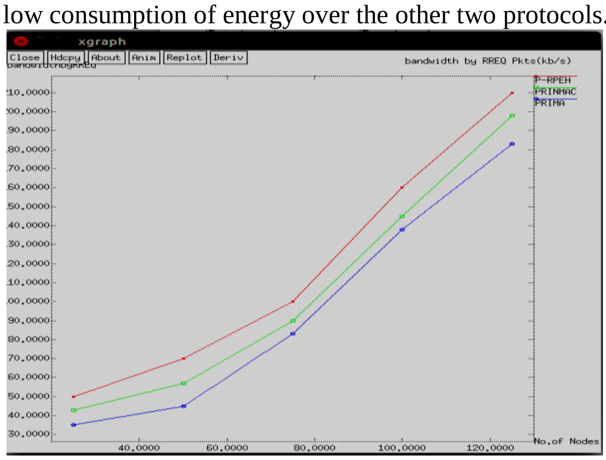
a. Bandwidth versus Number of Nodes
b. Energy versus Number of Nodes
c. Delay versus Number of Nodes
d. Throughput versus Number of Nodes
e. Packet delivery Ratio versus Number of Nodes.

4.1 .Bandwidth v/s Number of Nodes:

The allocation of resource such asbandwidth for the nodes which are of different sizes in the real time environment for various protocols wastaken into consideration. They were compared with the proposed new protocol. The comparison of graph is presented in the figure 4. It is clear from the graph that by varying the size of the nodes the size of bandwidth hasalso increased. The point to note here is that our present work gives a significant rise in bandwidth over the other two protocols.

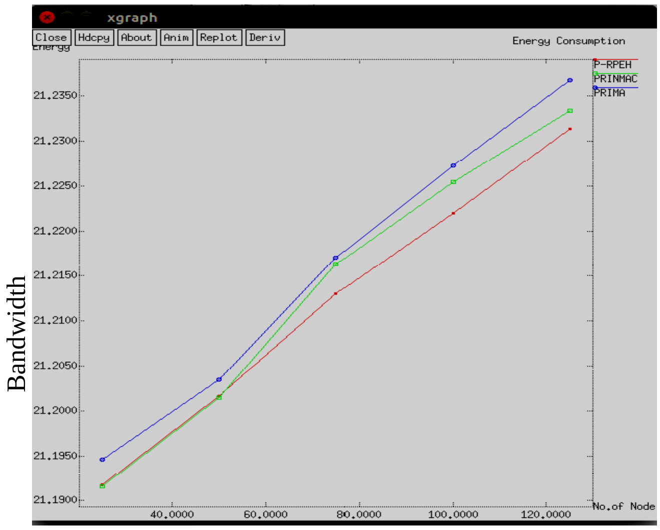
4.2 . Energy v/s Number of Nodes:

The consumption of energy likewise for various protocols was taken into consideration, and compared with PPREH, the proposed protocol. The graph with respect to energy v/s Nodes for different protocols isshown in figure 5. It is evident from the graph that asthere is increase in the size of the nodesthere is a decrease in the energy consumption.It also clearly indicates that the P-REPH protocol gives a significant low consumption of energy over the other two protocols.



No of Nodes

Figure 4: Number of Nodes *vs*Bandwidth



No of Nodes

Figure 5: Number of Nodes *vs*Energy

4.3Delay v/s Number of Nodes:

The delay versusthe node Number for different protocols is presented in figure 6. It can be observed that as the number of nodes are increasing,delay decreases in general. Until 110 nodes the delay decreases greatly for P-RPEH protocol. There after there is a marginal increase in delay compared to PRIMA, but it is still better than PRINMAC. This result is further discussed in the bar graph at a later point in this paper.

4.4Throughput v/s Number of Nodes:

The next parameter throughput may also be considered as one of the important parameters to measure QOS. The graph for the nodes of different sizes in the real time environment for various protocols is present in figure 7. It is evident from the graph that as the node size increases the throughput also increases.The inference we draw from the graph is that there is a significant increase in throughput from the newalgorithm when compared with the other two existing protocols.

4.5 Packet Delivery Ratio v/s Number of Nodes:

The results of packet delivery ratio v/s the number of nodes is presented in figure 8. When the results of Packet delivery ratio of P-RPEH is compared with the PRINMAC and PRIMA protocols.The graph illustrates that asand when the size of the nodeincreases, the packet delivery ratioalso increases.Up tonode 100 there showsan increase in the packet delivery ratio for the protocol that is newly proposed, but after that the level of increase for the algorithm that we have developed is almost same when compared with the other two protocols.

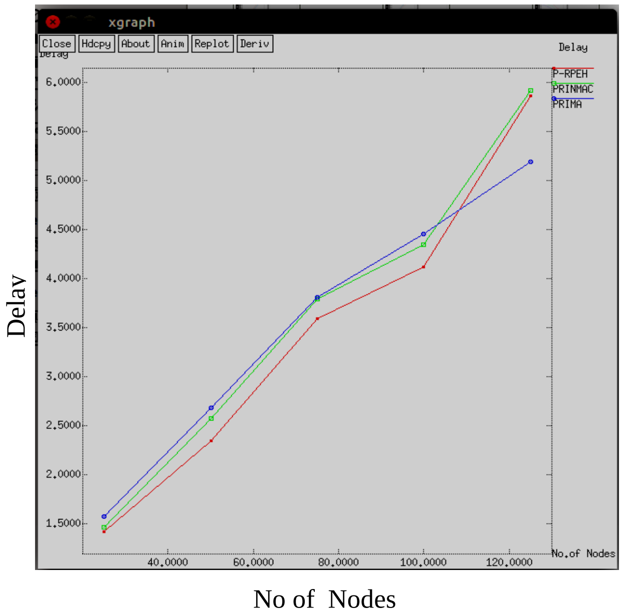


Figure 6: Number of Nodes *vs*Delay

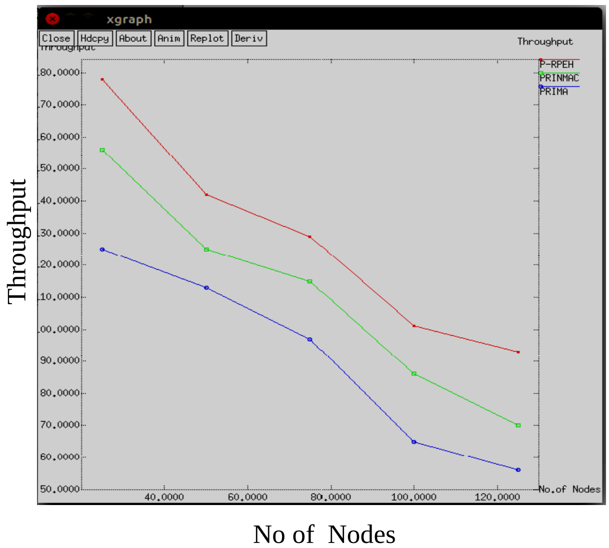


Figure 7: Number of Nodes *vs*Throughput

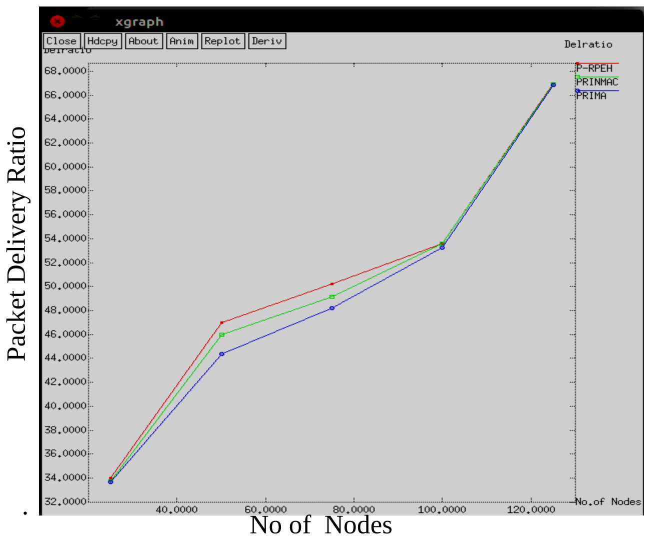


Figure 8: Number of Nodes *vs*Packet Delivery Ratio.

The QOS parameters for all approaches are compared. After the comparison it is observed that the QOS parameter of our work yieldssignificantly better results than the existing ones which are PRINMAC and PRIMA protocols. The QOS parameters of interest of the newly developed protocol compared with the existing ones are presented in bar graph from figure 9 to figure 13. It is clearly evident from the figures that ournew proposed protocol outperforms better in the QOS parameter terms such as Bandwidth, Energy, delay, throughput and the packet delivery ratio in our prioritized method.

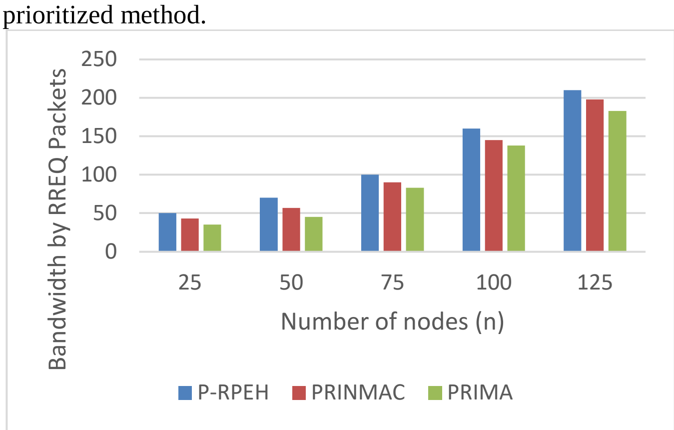


Figure 9: Comparison of *Bandwidth*

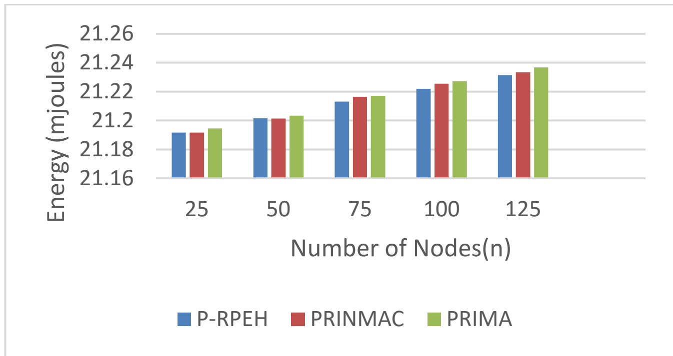


Figure 10: Comparison of *Energy*

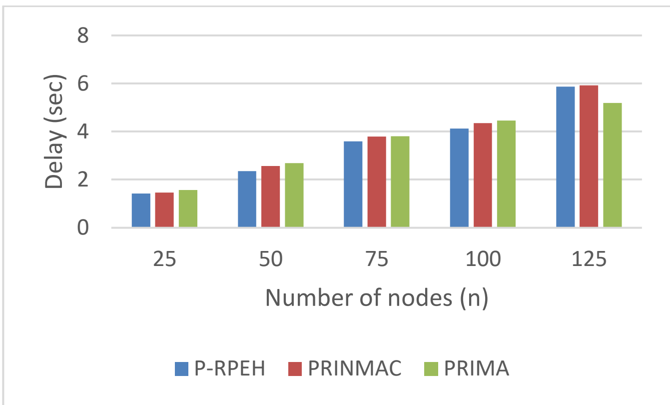


Figure 11: Comparison of *Delay*

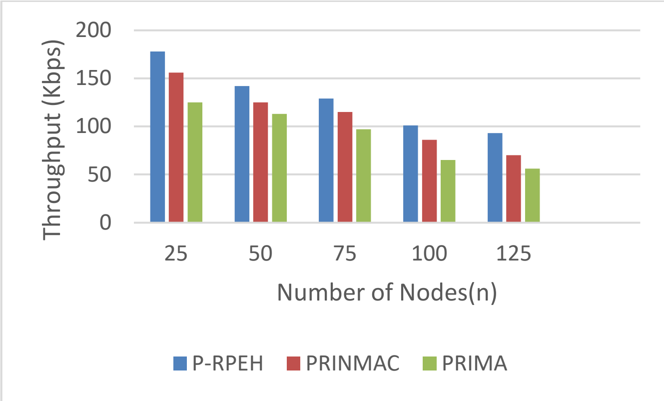


Figure 12: Comparison of *Throughput*

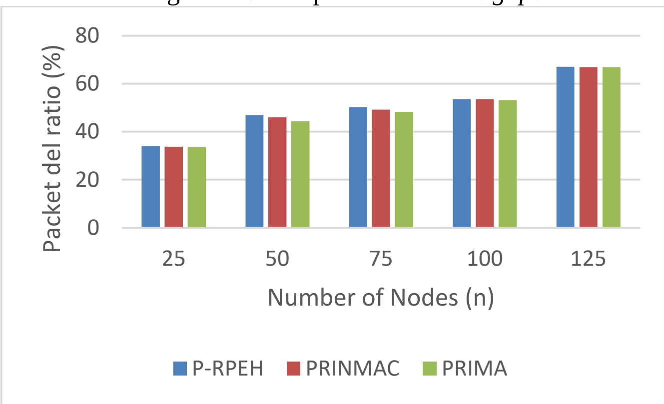


Figure 13: Comparison of *Packet Delivery Ratio*

The improvement in Performance of P-RPEH with the existing PRINMAC is presented in Table 3. Similarly,P-RPEH with that of PRIMAis presented in table 4.

No of Nodes	Parameters	P-RPEH	PRINMAC	Percentage improvement (P-RPEH with PRINMAC)
25		50	43	16.28
50		70	57	22.81
75		100	90	11.11
100		160	145	10.34
125	Bandwidth	210	198	6.06
25		21.19174	21.19457	0.01
50		21.20165	21.20345	0.01
75		21.21302	21.21631	0.02
100		21.222	21.22541	0.02
125	Energy	21.23134	21.23334	0.01
25		1.4127	1.4567	3.11
50		2.3456	2.5678	9.47
75		3.589	3.789	5.57
100		4.117	4.3452	5.54
125	Delay	5.8687	5.9234	0.93
25		178	156	14.10
50		142	125	13.60
75		129	115	12.17
100		101	86	17.44
125	Throughput	93	70	32.86
25		33.987	33.756	0.68
50		46.986	45.978	2.19
75	Packet	50.234	49.156	2.19
100	delivery	53.589	53.578	0.02
125	Ratio	66.998	66.912	0.13

Table 2

No of Nodes	Parameters	P-RPEH	PRIMA	Percentage improvement (P-RPEH with PRIMA
25		50	35	42.86
50	Bandwidth	70	45	55.56
75		100	83	20.48
100		160	138	15.94
125		210	183	14.75
25		21.19174	21.19456	0.01
50		21.20165	21.20343	0.01
75		21.21302	21.21703	0.02
100		21.222	21.22723	0.02
125	Energy	21.23134	21.23678	0.03
25		1.4127	1.567	10.92
50		2.3456	2.6789	14.21
75		3.589	3.8077	6.09
100		4.117	4.4567	8.25
125	Delay	5.8687	5.189	-11.58
25		178	125	42.40
50		142	113	25.66
75		129	97	32.99
100		101	65	55.38
125	Throughput	93	56	66.07
25		33.987	33.654	0.99
50		46.986	44.345	5.96
75	Packet	50.234	48.234	4.15
100	delivery	53.589	53.234	0.67
125	Ratio	66.998	66.845	0.23

Table 3

V. CONCLUSION

In this paper, we presented the P-RPEH, which is aQOS MAC protocol which improves the bandwidth as well as energy efficiency using priorityfor the wireless sensor networks. P-RPEH has combined the benefits of the residual power and energy harvesting rate,which aims to achieve significant amount of resource savings. To guarantee the Quality of Service, priority approach is used.

To conserve resources, P-RPEH protocol enables the nodes with maximum energy to transmit the data and lower priority nodes to go to sleep state. This avoids wasting of resources and uses TDMA schedule to transmit the data for communication process.

A great amount of work was carried out on P-RPEH Protocol. Its performance was analyzed through Simulation. The QOS parameters were compared with PRIMA and PRINMAC protocols. From the results obtained we conclude that the proposed work with a new protocol outperforms the other existing ones in terms of bandwidth, energy, delay, through-put and packet delivery ratio.

FUTUREENHANCEMENTS

The number of nodes considered in the present work is from 25 to 125. The work can be enhanced to greater number of nodes.The delay in the system can also be further decreased.

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