DEVELOPING THE ENERGY EFFICIENCY BY OPTIMIZING THE ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL IN WIRELESS SENSOR NETWORKS

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ABSTRACT: The process of wireless sensor networks is facing the problems of transmitting the data as well as the consumption of energy in the network. This difficulty will badly influence the network's reliability. Hence the method of data aggregation was extremely helpful in collecting the data by minimizing the amount of data transmission and enhances the lifetime of the wireless sensor networks. This method fails to determine the optimal route from source and destination since the method concentrated only on collecting the data. Hence the existence of the On-Demand Distance Vector Routing Protocol (ODVRP) is an extensively used protocol for transmitting the data. In Differentiated Data Aggregation Routing (DDAR), the path must be found by source node which will broadcast the Route Request (RTREQ) packet. But the transitional nodes will have less lifetime in forwarding the request. The lifetime will get expired soon and it will not be able to broadcast the Route Reply (RTREP) in the opposite direction. Then the source will again continue the same procedure by sending the request from source to destination. This may end in lowering the Packet Delivery Ratio (PDR) and rebroadcasting the RTREQ. The problem can be rectified by the evolution of the Optimized ODVRP (OODVRP) routing method. Here the source node will check for the lifetime of the battery and once the node is filled with adequate energy level the source will start sending the RTREQ and it will wait for the density of the node to surpass the threshold. These factors are considered, and they are examined by the OODVRP method by executing the identification of the route and eliminating the excessive data transmission effectually. The OODVRP is compared with DDAR and it is proved the new algorithm is highly effective in determining the level of throughput and lifetime of the network.

KEYWORDS: Aggregation, Data Transmission, OODVRP, DDAR, Rebroadcasting

I. INTRODUCTION

The new technology came into existence in this decade is wireless sensor networks (WSNs). The motto of this technology is to observe the remote areas. The sensor nodes will contain a restricted amount of energy and that leads to offering an amount of energy for a certain time in these types of networks [4]. The replacing or restoring the batteries of the sensor node is very problematic and this is not feasible particularly in remote areas. These parameters are taken by the investigators where energy is the vital source for wireless sensor networks. Hence the various methods and protocols are projected which has motivated them to determine the solution to these kinds of problems. Hence the algorithms are created to effectively utilize the energy resources of the nodes and to expand the lifetime of the network.

The communication unit is the power-consuming unit in the sensor node. The more amount of information is sent from the sensor node where the energy depletion takes place [2]. Thus, the reduction of data made the investigators for providing the solutions to solve this problem by saving the energy in the network. The reduction of data will eradicate the repeatedly sensed information which helps to extend the lifetime of the network. The data minimization should not influence the part of the accuracy and quality of service. The accuracy level is based on the decision taken by the user and the requirements of the application. Hence the other demanding criteria are assessment among the accuracy and data reduction.

The research focusses on the reduction of data in wireless sensor networks in recent years. The radio unit present in the sensor node also consumes more power which is next to the communication unit. So, the data reduction methods are employed to expand the lifetime of the network. Data aggregation and network's lifetime are the most appropriate methods for this proposed work. The data aggregation helps to collect the data [1]. A similar number of packets are sent by the sensor nodes in a different amount of time and the packet size is also the same. The output is carried by a packet and this type of calculation is said to be partial value in a network for

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aggregation. The data reduction can be performed but the transitional nodes do not have the energy power like the source nodes. The transitional node's level of energy may be restricted. Hence the observation on sensor nodes is more crucial in wireless sensor networks.

The applications of Wireless Sensor Networks (WSNs) are utilized today and in the future too. But the problem associated with the wireless sensor network is reliability when compared to wired networks. This is due to the usage of low-priced hardware devices, restricted range of radio units and restricted amount of energy. Since the range of applications is increasing in the industries, they need a more reliable network. The demands regarding the application and the existing methods are evaluated and the results are provided [3]. The mechanism like data collection and data transmission are examined in wireless sensor networks.

The Wireless Sensor Networks (WSNs) comprises of WSN nodes and said to be wireless networks that are executed with a restricted amount of energy like batteries. They are often called a battery-operated device. The nodes of the WSN are WSN nodes that are constructed across the transceiver, sensor nodes, storage nodes and microcontroller unit. The wireless sensor networks are installed for attaining goals like observing the environment, calculating the integrity of the bridges and observing the amenities of the industries. This type of network is applicable for energy efficiency which plays a major role in enhancing the battery lifetime and the lives of the batteries can be improved by permitting the cost-effective mechanism of various nodes. This type of wireless sensor network application is best fitted for this type of problem [6]. Many types of methods are not reliable, and it is said to be unreliable because of the following:

1. The links in the wireless networks are unreliable since the transmitters present in this medium do not have high power. This type of low power transmitters is present in WSN hardware.

2. The hardware parts of wireless sensor networks are cheap and the rate of failures on hardware is high due to the outages of the node.

3. The energy level is restricted in wireless sensor networks which creates the problem in nodes which leads to energy depletion in batteries.

But certain applications need more reliability level while transmitting the information across the network. The reliability problem can be explored and solved by executing the vigorous methods of networking which will handle the intrinsic irregularity problems held in wireless sensor networks. The reliability parameter is not simplified in the context, but it is said to the total number of packets that are sent and how many packets are delivered to the destination. The ratio of total packets sent and received is termed to be reliability [5]. There is a deadline associated with the networks for sending the packets to the destination. The packets must be sent before the deadline else the information is pointless. The reliability is the parameter to calculate the data packets sent and received within the specified amount of time. The methods for data collection, reliability, packet delivery ratio is demonstrated and the methods are evaluated and compared with the existing methods.

The problem can be rectified by the evolution of the Optimized ODVRP routing method. Here the source node will check for the lifetime of the battery and once the node is filled with adequate energy level the source will start sending the RTREQ and it will wait for the density of the node to surpass the threshold. These factors are considered, and they are examined by the OODVRP method by executing the identification of the route and eliminating the excessive data transmission effectually. The OODVRP is compared with DDAR and it is proved the new algorithm is highly effective in determining the level of throughput and lifetime of the network.

II. RELATED WORK

The concept of rumor routing was introduced, and it serves as a coherent negotiation among the set of queries and events. In this method, multiple paths are created which are not optimal preceding to the events. The event of interest is created, and the created query can run until it attains a path that is nearest to the event [7]. The flooding of the query can be performed at the last stage when the query will not cross such paths. The investigators employ the method of two lines connecting the rectangular region which helps to identify the credibility of the solution. The objective of the method is to create the routes for the events. The long-lived agents are generated by generating the paths to the event.

The two-level hierarchical routing protocol is introduced which is called LEACH. Here they will reduce the energy depletion in the network and it will deliver the consumption of energy among the nodes. The problem is resolved by introducing the clusters with the local synchronization, high-level energy cluster heads are rotated and data compression. The model contains a base station that does not have any energy restrictions, a huge amount of sensor nodes that are inactive, standardized and energy controlled [8]. The location of the base station is near to the sensor nodes but the cost of communication between these two nodes is high. The method will

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help the network to gather the data by sensing and it is forwarded to the base station. The raw information is high, and it is split into a small amount of useful information. Since the data is split into small amounts the process is also split into various rounds. During this round, the clusters are dissipated and again created. The cluster head will be decided in each round. This is executed by the number of cluster heads in the network. The cluster heads will denote their thoughts and the other nodes will decide after listening to their thoughts about joining the cluster. The signal strength is the criteria for joining the cluster. The cluster head will create a schedule when the cluster formation is executed. It will be sent to the other members of the network. The interference can be minimized by communicating with other clusters in the network.

III. EXISTING SYSTEM

3.1 DIFFERENTIATED DATA AGGREGATION ROUTING (DDAR)

The Differentiated Data Aggregation Routing (DDAR) will generate the service tag and the service tag mainly helps for data collection. The service tags are generated based on the number of service requirements given by the nearby sensor nodes. The value of packet aggregation and packet aggregation timers are calculated based on that tag. The aggregator node is then selected by the sensor node which is said to be the packet's destination. The aggregator will introduce a next-hop route with the service tag. The service tags are configured in phase 1. The tags are initialized for communication. The service tag allocation is shown in Figure 1.

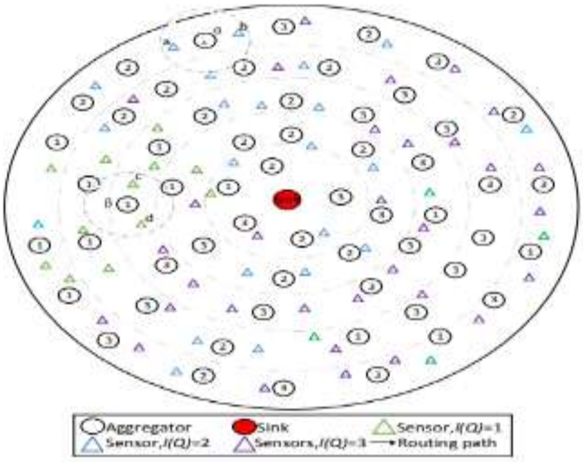

Figure No: 1 Service Tag Allocation

The next phase is to set up the data aggregation and its timers [9]. The factors which are higher than the aggregation and the timer value then the average delay in aggregation will increase the timer value of aggregation. Once the service tags are identified then the aggregation and the timer values are calculated. The next phase is to determine the next nearest aggregator. Since the power of the sensor node is limited, the information which is sensed should be transmitted to the sink with the help of aggregator nodes. The sensor will choose the service tag to collect the data by taking the shortest distance. The next phase is given in Figure 2.

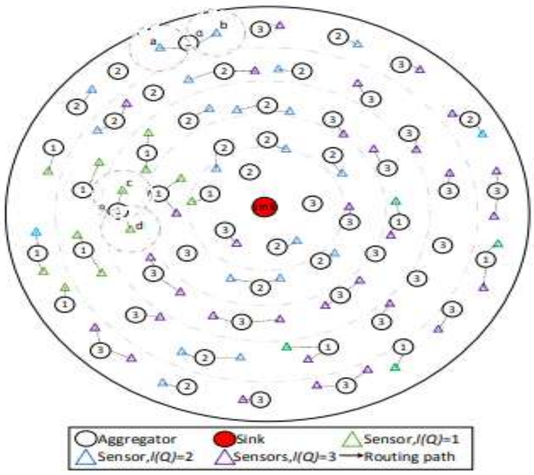

Figure No: 2 Service Tag Selection

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Once the service tags are chosen by the aggregators then the next step is to find the route for data collection. The nodes which do not have the tags are informed to form a tag with different tags. During the next hop, the other nodes which do not have a tag will identify the service tag which will ensure that all nodes have the service tags and they are shown in Figure 3.

Even though the service tags are set up for data collection it fails to find the lifetime of the battery and node density. The packets have to be passed from source to destination without any delay. Hence the routing protocol called "Optimized On-Demand Distance Vector Routing Protocol (OODVRP)" is proposed to resolve this problem.

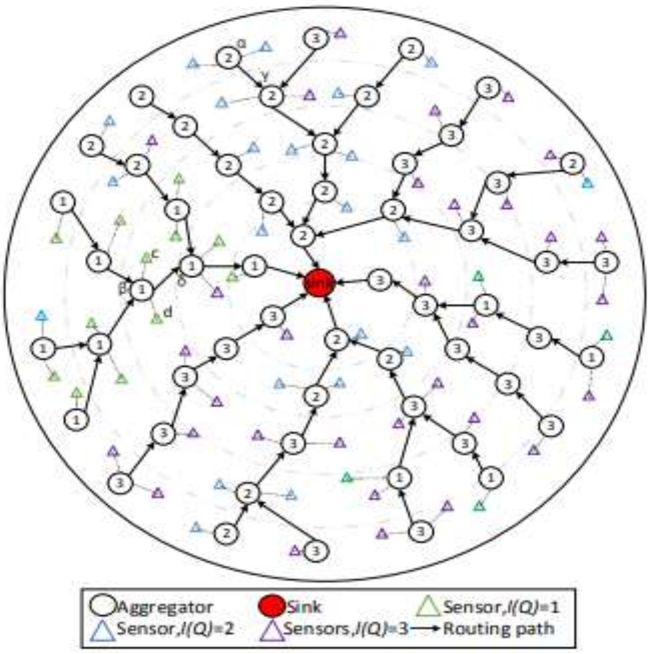

Figure No: 3 Neighbor Node Aggregation

IV. PROPOSED SYSTEM

4.1 OPTIMIZED ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL (OODVRP)

The Optimized On-Demand Distance Vector Routing Protocol (OODVRP) helps to determine the lifetime of the battery present in the network. This is executed with the help of three messages such as Route Request (RTREQ), Route Reply (RTREP) and Route Error (RTERR). When sending the packets from source to destination and if the course of travel is not found then the source node will start to send the Route Request (RTREQ) by initiating the packet requisition to all other nodes in the network. This message will contain an IP address of the source and the destination node, the identity of RTREQ and hop count [10]. The RTREQ ID will be increasing continuously. This will get incremented automatically when every node in the network initiates an RTREQ. The request flooding method is given in Figure 4.

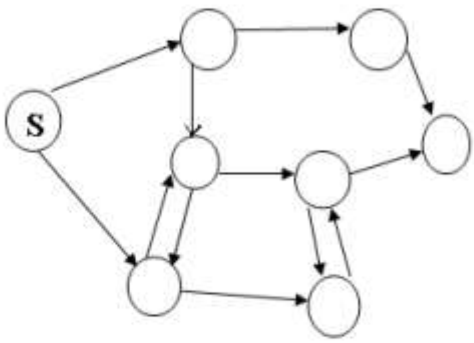

Figure No: 4 Flooding Of RTREQ

Once the source starts to flood the RTREQ request to find the path then the transitional nodes in the network will receive the RTREQ message and they will generate the opposite link to the earlier node. Then the routes are checked here. They will check whether the selected route from source to destination is valid or in an invalid state. If the route is found to be valid then it should satisfy the next criteria. The other criteria are the sequence number of the transitional node should be more than that of the destination node's sequence number. When these criteria have met the node it will produce an RTREP message which is called a reply message. When the condition is not satisfied the node will continue to broadcast the RTREQ message. Once the message is broadcasted the hop count will get incremented. The transitional nodes will start the timer while broadcasting the RTREQ message.

Still, if there is no reply in the link then it will conclude that there are no active nodes in the network. This may think that there is a link failure. RTREP is comprised of source and destination IP address and the sequence number of the destination node. When the broadcast route entry is generated it will send the acknowledgment that RTREP can be sent from source to destination. The hop by hop broadcasting is executed to the source node and it is shown in Figure 5. When the RTREP message is received by source node then the source can utilize the route for data packet transmission.

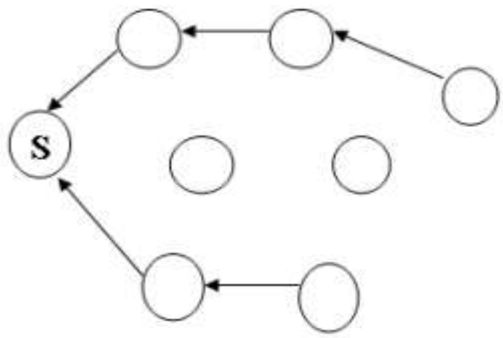

Figure No: 5 RTREP Flooding

Since the nodes are changing the failure may occur in the link. The breakages may happen in the network. When there is a link failure the source and destination node will inform about the breakages in the network. The path that is used by the sender will be informed about the link failure which helps to send the error message and it is given in Figure 6.

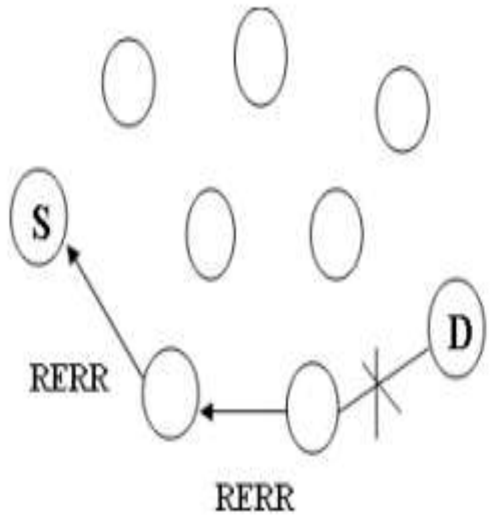

Figure No: 6 RTERR Flooding

The nodes present in the network will remove the entries about the path from the routing table since the path is not useful. When the source wants to communicate in the same path then the source will again broadcast the RTREQ message to the other nodes or it will try to repair the failure link. The proposed work contains a routing table that is comprised of a node's battery lifetime and density. The values are stored in the routing table. The

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transitional nodes present in the network will not send the RTREQ message immediately to the destination because it will check the lifetime and density value in the routing table.

The lifetime and density are calculated by the three messages called RTREQ, RTREP and RTERR. The method is given as follows:

- Initialize the nodes
- Determine the parameters for routing - Threshold value, Sequence number and IP address
- The sender initiates the RTREQ
- Check the battery lifetime and density of the node
- Set up the threshold values
- Compare the lifetime and density with the threshold value
- If the value is greater than the threshold, then the RTREQ message can be forwarded
- If the value is lesser than the threshold, then it will suspend the RTREQ message
- The packets are buffered until the value reaches the threshold level
- Resend the RTREQ
- End

The second criterion to forward the packet is there should be an adequate number of nodes to broadcast the RTREQ. To initiate this process, Hello message is used. Hello message will be forwarded to other neighbor nodes in the network. The two threshold values are introduced and named it as THR and THS and it is said that the node which receives RTREQ message and the battery lifetime and density of the received node should be greater than that of the threshold value. If the value is greater then the RTREQ message will be successfully sent to the destination node. When the value is less than the threshold then the packets are buffered by the transitional nodes and the procedure is repeated until it reaches the threshold level. The method will minimize the superfluous packet resending and it will also help to enhance the throughput.

V. RESULTS AND DISCUSSION

The Optimized ODVRP (OODVRP) will help to calculate the lifetime of the battery and the density of the node. The information about the lifetime and the density are noted in the routing table. Once the lifetime of the node is checked it will calculate the node density. There should be an adequate number of nodes to broadcast the request message. When the lifetime and density of the transitional nodes are higher than the threshold value then the data transmission is successful. The lifetime of DDAR and OODVRP methods are illustrated in Table 1 and Figure 7.

Table No: 1 Battery Lifetime

Number of Nodes	Battery Lifetime - Simulation Time (in a sec)	
	DDAR	OODVRP
1	118	120
2	117	121
3	116	125
4	110	130
5	108	135
6	99	137
7	88	139

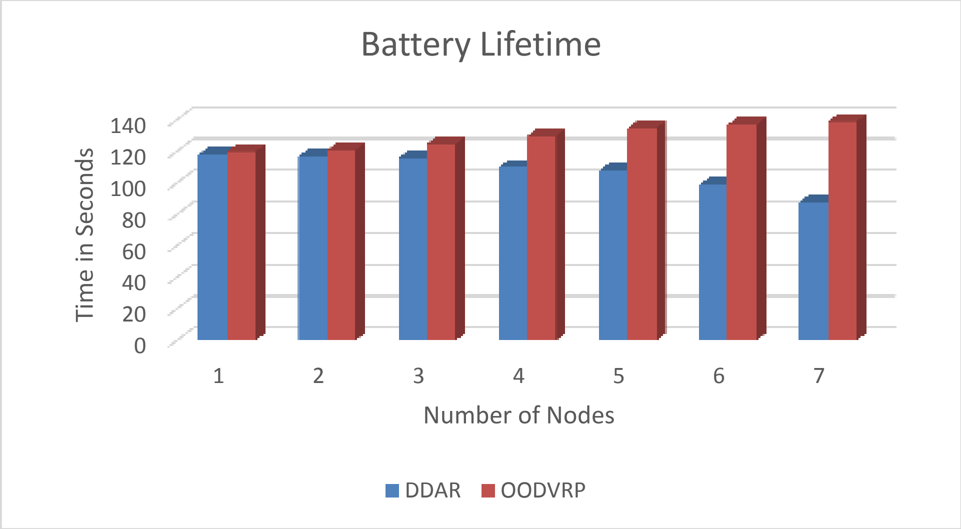

Figure No: 7 Battery Lifetime

The throughput is measured by calculating the number of packets passed through the intermediary nodes. The projected work is more effective in forwarding the request and network lifetime is enhanced here. The number of packets traveled through this network is high because the node's threshold values are compared and noted in the routing table. This helps to send the packets from source to destination after checking the lifetime of the battery. The throughput is given in Table 2 and Figure 8.

Table No: 2 Throughput

Time (seconds)	Throughput (kbps)	
	DDAR	OODVRP
0	0	0
20	82	93
40	91	102
60	110	205
80	128	230
100	137	280
120	151	309

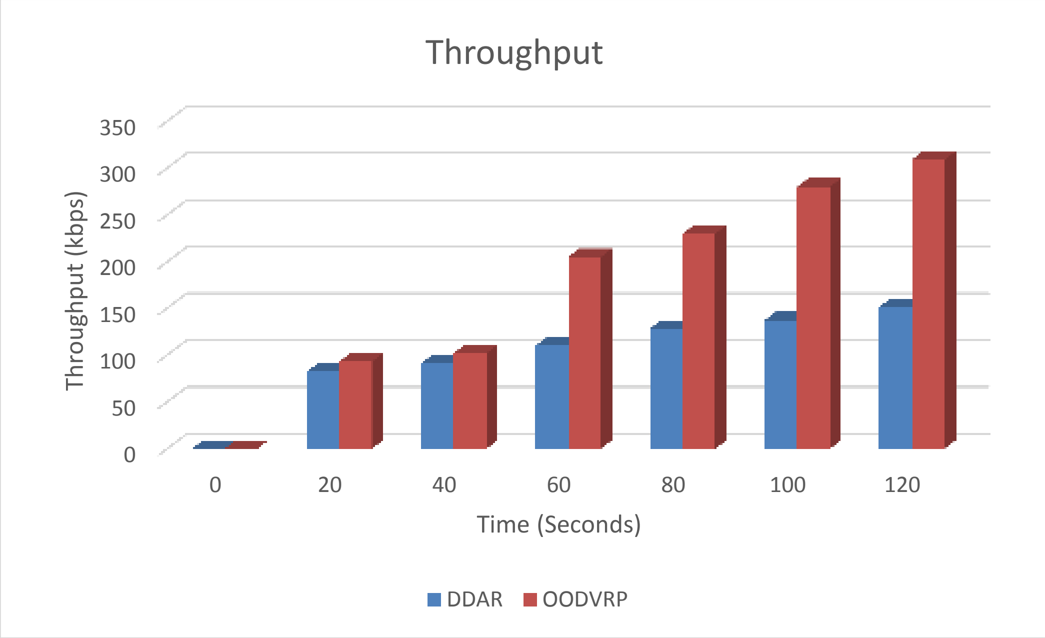

Figure No: 8 Throughput

The next parameter is the Packet Delivery Ratio (PDR). It is defined as the total number of packets sent from source to destination. In the existing system, it does not compare the threshold value with the transitional nodes. It fails to check the lifetime of the node. Since the lifetime of the battery is not determined the packets are not sent from source to destination. The packets are initiated from the source, but it is not passed through the intermediary nodes in the existing system. The throughput ratio is calculated in Table 3 and Figure 9.

Table No: 3 Packet Delivery Ratio (PDR)

Time (seconds)	**Packet Delivery Ratio (%)**	
	DDAR	**OODVRP**
0	0	0
20	10.12	18.26
40	28.23	46.24
60	42.65	59.82
80	65.71	72.56
100	80.13	85.23
120	87.12	97.03

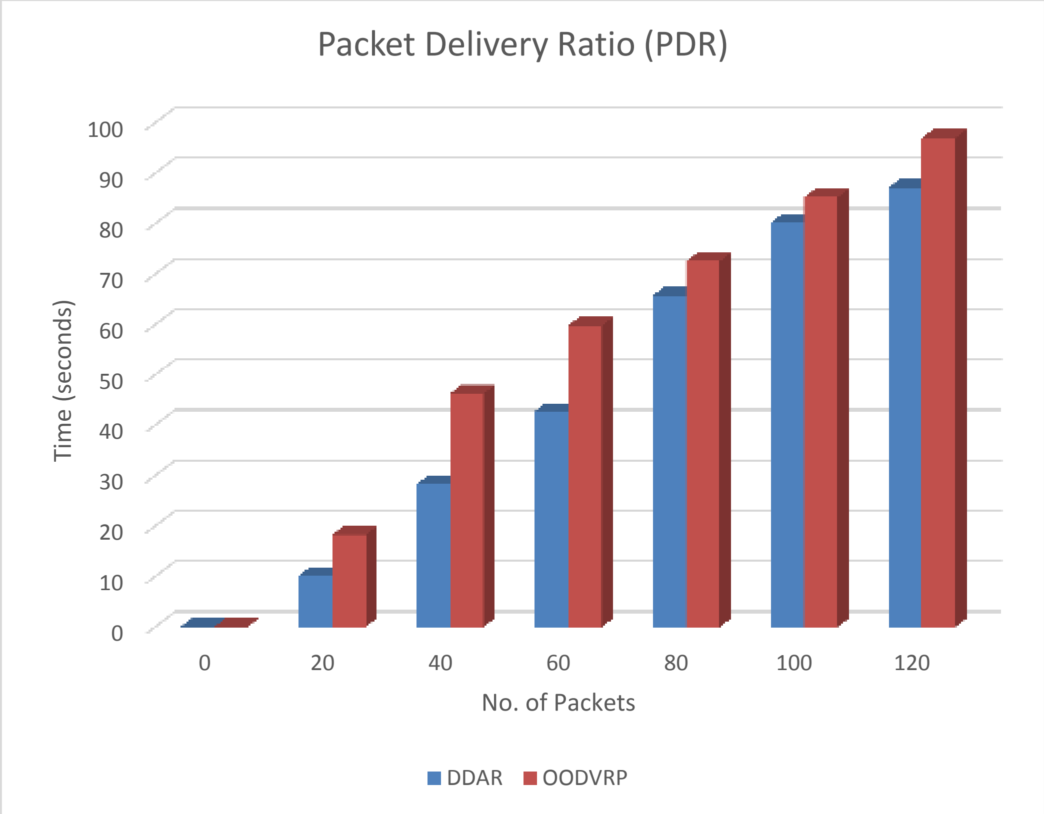

Figure No: 9 Packet Delivery Ratio

Energy efficiency plays a major role in wireless sensor networks. The DDAR method always focusses on collecting the data from various nodes. It fails to ensure the lifetime of the network. The proposed work creates the threshold and it will compare the transitional node density with the threshold value. If the value of an intermediate node is higher than the threshold then it is good to reach the destination which will enhance the energy efficiency of the network. It is given in Table 4 and Figure 10.

Table No: 4 Energy Efficiency

Time (seconds)	**Energy Efficiency (nJ)**	
	DDAR	**OODVRP**
0	100	100
20	86.25	90.86
40	75.36	85.23
60	63.25	80.36
80	59.20	72.53
100	54.23	69.23
120	51.20	62.01

Figure No: 10 Energy Efficiency

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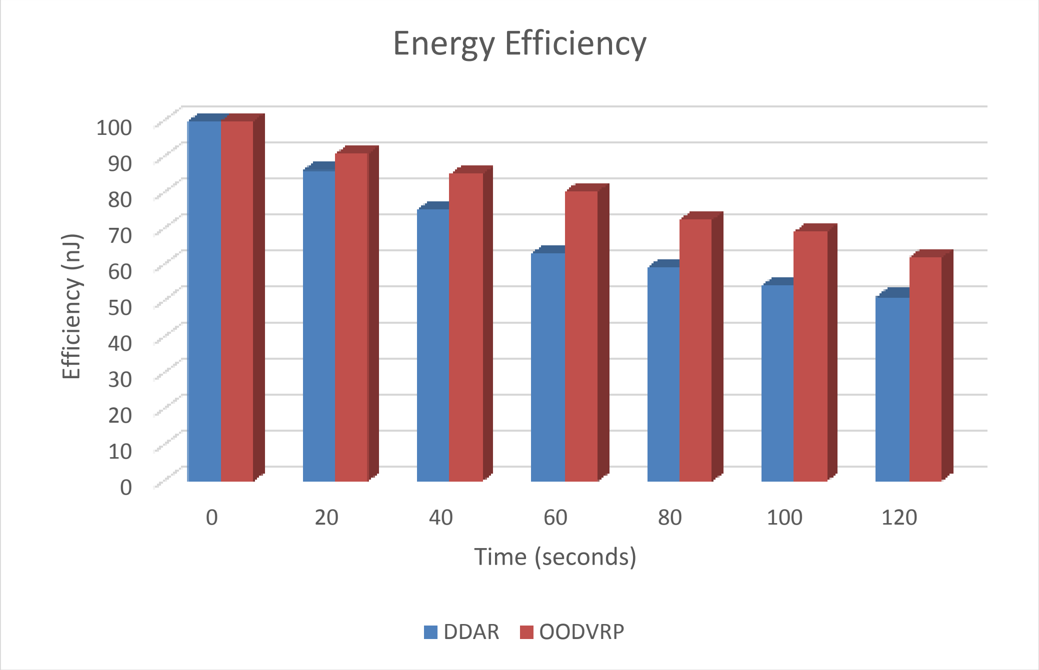

VI. CONCLUSION

The proposed work OODVRP manages the importance of a node's energy in the network. This type of energy-efficient optimization protocol which modifies the work of Differentiated Data Aggregation Routing. In the DDAR method, the service tags are set up for data collection. But data collection alone is not enough for transmitting the data. Hence the drawback can be overcome by an optimization routing protocol. This proposed protocol aims to find the lifetime of the battery and density of the node. The values are collected in the routing table. The values help to raise the request from the source to all other nodes in the network. The routing table values are compared with the threshold values which helps the nodes pass the request message. Once the values are lower than the threshold it need not wait it will immediately send the error message. Hence this method is more effective for enhancing the energy efficiency, throughput and packet delivery ratio of the network.

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