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Original Article

Performance Evaluation of CBGNR, CBDGR Routing Protocol in WSN

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Abstract: *Increasing the throughput of a wireless sensor network is a descriptive term for an efficient routing technique that creates an efficient network. Wireless Sensor Network is used to develop an efficient and authentic wireless network model. A WSN obtains information from a large network, where a small sensor node collects information from its chain and sends data to the master node. The lifetime of nodes depends on battery power and WSN data collection in chain form. In a wireless environment, it is not possible to supply extra power or recharge nodes. So here we will use a gateway node that has uninterrupted power. In the WSN routing protocol, it takes extra energy when a node changes its position in the network, making the throughput poor. Wireless sensor network WSN has some reason to reduce throughput and packet delivery. There are some reasons in the network for reducing throughput, such as the multi-hop path, the maximum number of hops, the maximum distance for each hop, and load density. In this paper, we have proposed an energy-efficient chain- based routing technique that minimizes the above problem. Our purpose-built technique achieves slightly better performance than both in terms of throughput, packet delivery, and power consumption.*

Keywords: *Chain Based Routing Protocol, Wireless Sensor Network Gateway Nodes.*

I. INTRODUCTION

At this age, everything is very fast and limited. The wireless sensor network is a big technology and a big platform. In this paper, we present a routing protocol in WSN. This protocol finds an advantage over CBGNR and CBDGR. Sensor networks consume more energy if node deployment is fast, path with multiple hopes, the maximum number of hops, the maximum distance for each hop, load density, and long-distance data transmission between nodes. Efficient routing technique is a term for reducing the aforementioned energy consumption of wireless sensor networks. In this paper, we aim to improve performance by reducing energy consumption in all critical conditions of wireless sensor networks. We will create an efficient routing algorithm [13][20].Wireless sensor networks are a combination of interconnected sensor nodes that communicate wirelessly and collect data from a neighbouring node. Wireless sensor network nodes work logically. A wireless sensor network consists of many different components, but a small part. The characteristics of a good wireless sensor network include energy efficiency, scalability, and reliability. A wireless sensor network with these features can prove to be very beneficial. Routing algorithms are the main concept that directly affects the performance of wireless sensor networks, if the routing technique is correct, then we are sure that the overall efficiency of WSN is better [9][20].

The efficiency of a wireless sensor network depends on the routing protocol. A WSN consists of a large number of small sensor devices. Each small sensor node has a quality of sensed data and limited memory. The second type of node is the master node, which has unlimited duties, so it loses its energy recently. In this article, we use a rechargeable master node at the point of battery power, where we use a gateway node to provide a solution to the above problem. The third step is Communication, which completes the network connection [21][18].

In this, we have taken some previous year's papers and tried to do them. First, create the chain head and base node. After the nodes are created, it connects the entire node to the chain head, the chain head connects, and the chain head connects to the base station (ch1->ch2->ch3->ch4->BS). All sensor nodes connect horizontally to the chain head and all chain heads connect vertically to the base station. In this case, each packet sends a message to the chain head, the chain head collects the data and sends it to the other chain head vertically. When the last chain head collects the data, it sends the data directly to the base station [18][19].

Now we will create our second network called Chain Based Gateway Nodes Routing for energy efficiency. In this network, all sensor nodes are connected horizontally. There is no chain head in this network. After creating the nodes, connect the entire node to the Gateway node (n1=>n2=>n3=>BS<=n3=<n2<=n1). All sensor nodes are connected horizontally. In this case, each packet sends a message directly to the gateway node[9][19].

The third step is the communication unit, which creates a direct connection to the network [9][18]. All nodes with their gateway node (vertically n1=>n2=>h1<=n2<=n1), the gateway node will connect the next rows of the gateway node, and then all the aggregated data will be forwarded to the base station (h1=>h2=>h3=>ch4=>BS). This entire means is that everypacket sends a message to the chain head; the chain head collects the data and sends it to the other chain head horizontally. When the last chain head collects the data, it sends the data directly to the base station [9][13][18].

II. RELATED WORK

Amir Hozhabri et al. [9] proposed chain-based gateway node routing for energy efficiency in wireless sensor networks, a chain-based routing protocol that uses a gateway node instead of a chain head node and the gateway node is rechargeable by solar batteries. The gateway node collects the data and sends the data directly to the base station. This routing algorithm improved overall performance.

RaziehSheikhpour, SamJabbehdari, et al. [13] gave the EECBR protocol for WSN to find the biggest goal of energy saving and network lifetime extension, this network reduces energy consumption. EECRP arranges the sensor node in a horizontal and vertical chain. Chain head selection is based on the remaining energy of the nodes, all horizontal chains send data to the chain head, and the chain head sends data to the base station.

Haydar Abdulameer et al. [6] present a backbone construction mechanism for a routing protocol for deterministic node deployment. The wireless sensor network protocol has the concept of multi-chain and multi- cluster and deterministic routing technique of node deployment, which finds the advantage of chain and cluster approach on small sensor devices and delivers specific data to the base station in a small organization, so this protocol extends the network lifetime and reduces node energy.

HA Marhoon et al. [7] purpose of DLRPRD chain-based technique for WSN. This routing project connects all nodes in the same column; each chain selects the chain head of its chain to connect directly to the base station by eliminating data redundancy. And also work in the deployment state to increase stability and extend the network lifetime.

Maninderjit Kaur et al. [16] Improving multi-gateway nodes in a wireless sensor network. It is a very efficient routing protocol. In the time of data, the communication node may fail, at that time it works better and increases the lifetime of the network, reduces the head node, and minimizes the energy usage of the node.

Rohini Sharma et al. [17] Multi-Gateway Based Energy Hole Routing Avoidance Protocol for WSN This paper reduced the transmission distance between sender and base station because the total area is divided into many Regions. The gateway nodes have taken a position in the optimal position. The sensor node directly communicates with the sink node. If the distance is less than a node or master node, no gateway is needed. It shortens the transmission distance between the sender and the receiver due to the available gateway node between the chain head and the sink node. It is therefore energy efficient for network extension.

QuadoudiZytoune, Driss, et al. [8] Optimized energy chaining technique for data collection in wireless sensor networks. Routing algorithms work for small networks and nodes that have limited capacity and deploy physical environments. Each node is itself configured in a node failover state. Present an ant colony optimization technique for on-chain data collection to enable network lifetime extension. It reduces the chaining of network nodes from the initial to the farthest node using greedy algorithms. The technique of chaining a network of nodes extends thelifetime of the network

HydarAbdulameer Maroon et al. [18] evaluation of Cluster Chain Mixed and Two Stage Chain protocol data link performance in wireless sensor networks. Power consumption is the main focus of the post. He designed a special routing protocol that reduced the energy of data transmission between nodes. CMM provides better performance with unused data access because the middle chain head is not responsible for delivering previous data, which reduces chain head power consumption and extends the network lifetime.

Awadhesh Kumar Maurya et al. [19] improved chain cooperative routing protocol in WSN. We proposed a chain cooperative routing protocol in WSN. The network is divided into subnets and each subnet has one chain head. Each cluster coordinator handles the load of one subnet. The chain gets information from a normal node and passes that information to the next cluster. The master node transmits information to the base station. The proposed technique reduces energy loss and increases the period of the network.

III. PROPOSED MODEL

In this paper, we need to use gateway nodes instead of the master node, which has a low cost and is more efficient than the simple master node [9]. Data transmission has three phases, the first is data transmission between sensor nodes in the vertical direction, and the second is data transmission between sensor nodes in horizontal chains. The last is the third step which creates a direct connection to the network [18].

A. Chain Formation

In the chaining phase, a sensor node sends data in its chain head, which uses chain-based routing. Sensor nodes are arranged in rows or columns. A sensor node transmits data to a neighbouring node and in the chain self [18][21]. All nodes send data to the chain head (n1->n2->ch1<-n2<-n1). the chain head will collect the data and send it to the base station (ch1->ch2->ch3->ch4->BS).

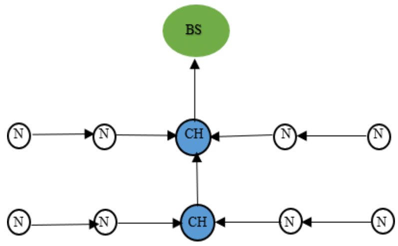

Figure 1: Chain formation

Each node sends a message to its chain node, and the next last node of the nearest neighbour nodes also sends data to its chain head. The master node collects the data and sends it to the other chain head. In the end, the head of the timing chain will collect the data and directly send it to the base station [18].

B. Selection of Chain Head Node

A chain head node is a recharge node, they know its location, and they also know the location of its chain. A chain node is like a gate node that has enough power because it provides a continuous source of power. In the chain, the sensor node and the CH node are arranged into types like S (1, 1), S (1, 2), and S (1, 3) .... S (1, n) and N (1,1), N (1,2), N (1,3) .... N (1, n). In this type of arrangement, the sensor nodes are available near the chain head, the chain head will be near the base station. When we start designing as the given pattern, start from (S1, S2 .... Sn). Similarly, on the other side, the formation of nodes will be similar (N1, N2......Nm). There are two representations of a node so that we can easily identify which type of node is working [9][19][21].

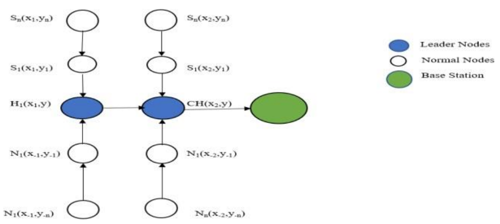

Figure 2: Chain Head Selection

C. *Data Transmission in a Chain*

Data transfer is based on a token mechanism at the beginning of each round. Each master node generates two received and broadcasts to its chain node. In this network, the last node (S1) sends data to its neighbor node (S2) and so on to the master node (H3). The master node (H3) sends data to the chain head (CH4), and the chain head sends data to the base station.

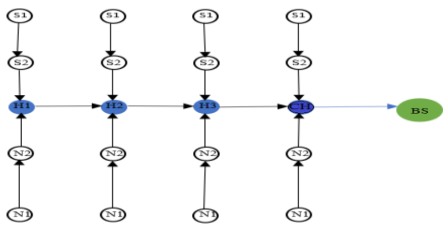

Figure 3: Data Transmission in a Chain

H3 is the master node, to create the chain, H3 will generate one token and transfer both neighbouring nodes of the chain H1 (S1, S2......Sn), H1 (N1, N2...... Nn). Both nodes of the chain Hn (S1, S2.......Sn), Hn (N1, N2).Take the token to the root node and at the same time return both the chain node collects data and pass it to the H3 master node. A network topology is used for the data collection process. Assume the head node H3 and their chain node S1(x1, y1) S2 (x1, y2) and N1 (x, y-1) N2 (x, y-2) ......S1 (x, y1), S2 (x, y2) ......N1 (x, y-1) N2 (x, y-2) are available in this way. Sensor node S1 (x1, y1) S2 (x1, y2) and N1 (x, y-1) N2 (x, y-2) will send data to H3 (x1, y). Sensor node S1 (x, y1), S2 (x, y2) ......N1 (x, y-1) N2 (x, y-2) sends data to H (x, y). Now the Chain Head CH (x, y) sends the data to the base station.

D. Energy Efficient Chain-Based Routing Protocol

The key idea behind PEGASIS is that nodes transmit or receive data from their nearest neighbour nodes. This is accomplished by creating a string. All nodes that collect data combine it with data received by a neighboring node and transmit it to the nearest neighbour. In this way, all nodes receive the fuse data and pass it to the next neighbour in a chain format until they all reach the base station. Each node in the network takes turns as the leader node of its chain, one leader node is responsible for transmitting the entire merged data collected by the chain of nodes to the base station. This will reduce the average amount of energy spent by each node. Greedy algorithms are used to display all nodes while building the chain. PEGASIS assumes low energy.

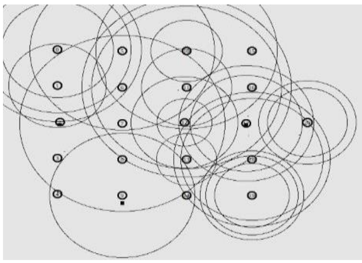

Figure 4: Energy Efficient Chain-Based Routing Protocol

A station can determine the path from the chain for all nodes, or all nodes can discourage their neighbours by sending a signal. Connection is dependent on signal strength; nodes adapt their signal to hear only the nearest neighbours in the network.

A greedy algorithm is used to create a chain between all the best nodes that are within one hop of each other and the base station. If the farthest node is selected, it will start transmitting data, send a signal to the nodes in the network to find the nearest neighbour, and send the sensed data.

It uses all the nodes of the network to create a chain and perform simple data transfer operations. If any node in the chain dies, a new chain is created to eliminate the dead nodes. Here, all nodes have an equal chance to become the leader once and transmit data to the base station in one round. The energy balance is estimated at the nodes in the network, which saves a lot of energy. The lifetime of the network is increased because all nodes actively participate and consume the same amount of energy as a whole.

IV. SIMULATION RESULTS AND DISCUSSIONS

We have used different network performance metrics to evaluate both the network architecture. In order to evaluate the performance of Chain Based Data Gathering Routing Protocol for Energy Efficient, we use an NS2. The main goal of this section is to test the CBDR Stability to reduce the overall end-to- end delay caused by the single long chain and power consumption. After the CBDGR finished the design, implementation, and validation steps, now it is important to evaluate the performance of Chain Based Data Gathering Routing Protocol for Energy Efficient.

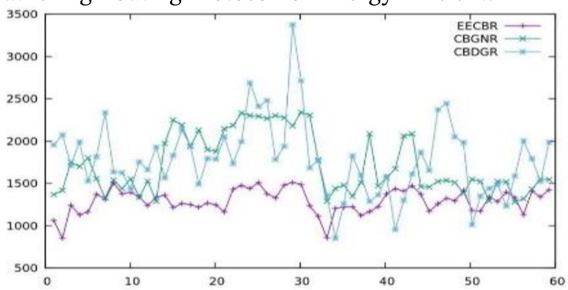

Figure 5: Instant Throughput of EECBR, CBGNR, CBDGR

We performed the simulation proposed in a self-organized network with 21 nodes. The size of each packet is set to 1.5 Kbit. The time for transmitting such a packet is considered as one delay unit.

Table 1: Simulation Parameters

Environment Size	1000x1000
Channel type	Wireless
Packet size	1500 bytes
Traffic Type	TCP
Protocol	DSR
Simulation Time	60 sec
Total nodes	21

A. Instant and Average Throughput

Network throughput is the rate (in bits per second or packets per second) at which packets or bits are successfully delivered over a network channel. The average throughput is calculated as the total number of successful packets received by all nodes divided by the given time and moment when it is calculated for a particular moment of power-up, called the instantaneous throughput. Permeability table and image are better than CBGNR, CBDGR shows fig.

$$TP = \frac{\text{Number of packets received}}{\text{Simulation Time}}$$

Table 2: Throughput Comparison

Network	Successful Packet Received	TP Value
EECBR	12303	1.640459
CBGNR	16362	2.181865
CBDGR	16994	2.259925

V. PACKET DELIVERY RATIO

PDR is the ratio of successfully received packets to the total number of sent packets and end-to-enddelay is defined as the time.

Table 3: Packet Delivery Ratio

Topology	EECBR	CBGNR	CBDGR
Send Packet	12530	16621	17219
Received Packet	12303	16362	16949
Packet Drop	227	259	270
Forward Packet	2521	632	6021
PDR	0.981883	0.984417	0.984320

VI. RESIDUAL ENERGY

A node loses a certain amount of energy for each packet transmission for each packet received. The energy of the initial node decreases. The current energy in a node after receiving or sending a routing packet is called residual energy. This metric was proposed by Lindsey et al.

Table 4: Residual Energy

Initial Energy	50 joules
Transmission power(tx)	0.9 watt
Receiving power(rx)	0.7watt
Idle Power	0.6 watt
Sleep Power	0.1 watt

VII. ENERGY CONSUMPTION

The energy consumption for all sensor nodes per wheel is considered an important metric that calculates the total energy dissipated for all sensor nodes per wheel during the lifetime of the network. The average energy consumption of nodes in rounds aims to study how reducing the energy consumption can increase the lifetime of the network. This metric can be calculated using the equation below.

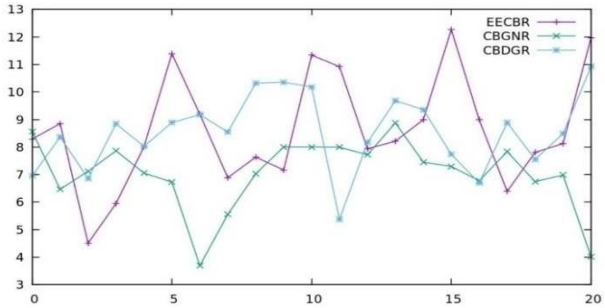

Figure 6: Energy Comparison of Each Node in EECBR, CBGNR, CBDGR

Table 5: Power Consumption Comparison

Topology	Average Energy Consumed(joules)
EECBR	42.35
CBGNR	44.07
CBDGR	42.00

VIII. EXPERIMENT AND PERFORMANCE EVALUATION

To evaluate the performance of the chain routing protocol, we use the NS2 simulator. We tested a group of sensor networks with 100 sensor nodes distributed in different sizes (50m*50m) and a 100m-by-100m grid as the image. Packet size set as 2k bits time delay 1 unit all nodes act as a chain.

$E = Ei\ (r)/r$

We use the take energy*delay matrix to calculate. The average energy consumed per round of the routing algorithm is estimated as

- In discrete transmission, the sensor node transmits its data directly to the base station, for direct transmission, high power is needed because it is a long chain.
- Applies to deterministic deployment with string-based access. Data transmission from the base station of the end node and the base of the cluster requires more energy in the cluster part and uses a sequential technique for chain head selection. Equations should be numbers as shown above.

IX. CONCLUSION

Energy consumption is a major concept in WSN for any routing protocol. The efficiency of WSNs depends on this routing protocol. A routing protocol is responsible for accurate and efficient data delivery in any environment. The main problem is the energy consumption during data transmission from CH to BS. Here, gateway nodes were used instead of using

CH nodes, CH nodes lose power quickly, and after the power loss, the CH node selection process started again. In this paper, we proposed a routing protocol to compare with two previous routing protocols CBGNR and CBDGR. we can find that EECBRP routing algorithms are better than both. The simulation results of our proposed protocol perform better in the whole network, the throughput is 27%, the packet delivery ratio is 33.27, and the energy consumption is 32.97% better than the compared routing protocol.

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