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An Energy Efficient Ring Routing Protocol for Wireless Sensor Network through Aggregator Nodes

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***Abstract*—Energy consumption is one of the challenging task in wireless sensor network due to the limited battery capacity of the sensor nodes. In wireless sensor network, the energy of the sensor nodes near the sink drains more rapidly than other nodes due to the data traffic focused towards the sink. To limit the problem of data traffic in a network, hierarchical routing protocol called ring routing protocol is used. In order to reduce the activation of the nodes and in-motive of reducing the energy consumed the ring structure is constructed with certain radius from the center node and the ring nodes are identified. The sensor nodes communicates and forwards its data to the ring nodes. In this paper, aggregator nodes are formed. Data aggregation reduces the energy utilization due to minimal amountof communication, which collects the data packets from the ring nodes. Thereby the aggregator nodes moves the data packets to the sink. This improves the energy efficiency of the entirenetwork.**

***Keywords*— Energy Efficiency, Data Aggregation, Wireless Sensor Networks, Ring Routing.**

I. INTRODUCTION

Wireless sensor network are spatially distributed autonomous sensor used for recording and monitoring the physical and environmental conditions such as temperature and pressure through wireless links. A wireless sensor network consists of small sensor nodes which are capable of sensing, communicating between each sensor node and processing the operations. Each sensor node may vary with size and cost and these results in resource constraints such as energy consumption, bandwidth and computational speed.The components of the sensor nodes are: sensing unit, power supply unit, storage unit and transceiver. In wireless sensor network, the communication between the sensor nodes may vary from single hop to multi hop communications. The sink in wireless sensor network may be static or mobile sink. The applications of wireless sensor network are in military, health care, security systems, home automation, industry, environment monitoring, battle field,wildlife monitoring and traffic monitoring.

A. Motivation of the Project

Themostimportantfactorinwirelesssensornetworkis theenergyefficiencydue tothelimitedcapacityofthe battery. Whilethesensornodesareplacedintheareaofstaticsinks, theenergydrainswhichcausestheenergyimbalanceproblem.To mitigate this problem, the hierarchical routing called ring routing protocol is used which defines the multi-tier hierarchy of roles among the sensor nodes.In the proposed method, among the sensor network the ring nodes are identified. The remaining sensor nodes communicates and forward its data to the ring nodes. The aggregator nodes are formed which collects the data packets from the ring nodes and finally data packets moves to the sink. This structure minimizes the energy consumption and reduces the data traffic near the sink throughout the network.

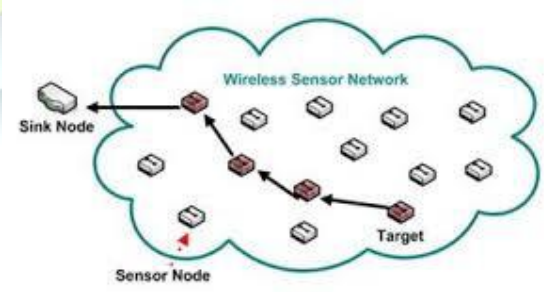

Figure 1. Wireless Sensor Network

B. Ring Routing in WSN

Ring Routingis the hierarchical routing protocol which forms the closed loop structure in the sensor network. The features of Ring Routing protocol are:

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- Ring Routing is targeted for large scale wireless sensor network.
- The ring structure can be modified.
- Ring Routing provides fast delivery of data packets.
- It reduces the data traffic and energy consumption in the sensor network.
- Ring Routing is suitable for event-driven and data reporting applications.
- Ring Routing uses the greedy geographic routing which is energy efficient and scalable.

C. *Data Aggregation*

In Wireless Sensor Network, aggregator nodes performs the data aggregation process. It is the process of combining the sensor data in order to reduce the amount of data transmission in the network. Careful selection of aggregator nodes results in minimizing the energy consumption and data traffic in the network. In the present work, aggregator nodes are formed near the base station. This reduces the data traffic near the sink and conserves the energy of the sensor.

II. LITERATURE SURVEY

Can Tunca and SinanIsik says that Ring Routing protocol is a hierarchical routing protocol. It forms a virtual ring structure which is energy efficient with the use of mobile sink. Here the mobile sink has to travel through the entire ring nodes to collect the data packets.

Xinxin Liu, Han Zhao proposed a trailing mobile sink to achieve efficient energy by forwarding data with multiple mobile sinks and also reduces the broadcasting mobile sink messages. Sink Trial establishes data reporting routes by selecting the shortest path to the destination which reduces energy consumption.

Subhadra Shaw suggested the global aggregator node which should be selected properly to save energy. The global aggregator (GA) reduces the communication with the base station or the sink. Hence huge amount of energy is saved due to the aggregation process.

Preethi Y.R., Manjunath C.R. says that aggregation aware routing algorithms play an important role in wireless sensor networks. The cluster based algorithm with data aggregation saves energy and extends the lifetime of the sensor network.

III. PROPOSED METHOD

The methodology proposed for Ring Routing protocol is data aggregation. The energy efficiency depends upon the selection ofrouting protocol. There are various routing protocols such as location based and flat routing protocols depending on the network structure. The available protocols failed to provide a consistent network in terms of balanced load, energy conservation and data traffic. Therefore hierarchical routing protocols resolves these difficulties in the network.

Ring Routing is a hierarchical routing protocol in which a center node is selected. With certain radius from the center node, the ring nodes are selected which forms the ring structure. An aggregator nodes are formed near to the sink or the base station. The aggregator nodes communicates and collects the data from the ring nodes and forwards it to the static sink. This improves the energy efficiency of the network as it does not requires to travel along the entire network to collect the data. Hence the time required and energy consumption will be less.

IV. RING ROUTING

Ring Routinguses greedy geographic routing. Geographic routing is an attractive solution as it is energy efficient and scalable. The protocol has three roles on sensor nodes. They are regular node, ring node and anchor node. Ring nodes form a ring structure and it is a closed loop of one node width. The three basics of Ring Routing are:

(1). Advertising the information of sink's position to the ring.

(2). Regular node obtains the sink's position information from the ring.

(3). The nodes disseminate their data through the anchor nodes and it serves as an intermediate agents connecting the sink to the network.

A. *Communications in Ring Routing*

Random deployment of nodes in the specified area of the network. In this, the area chosen is 1000x1000 meters and the number of nodes is taken at 100. Here the built-in facility of network simulator to generate the network with 100 nodes and mobility chosen is static. The base station is not part of our random deployment and is situated at any one of the four selected positions (bottom center, top center, vertical right edge center and vertical left edge center).Thenthe ring nodes are selected which will collect the sensed data from other normal nodes and forward them to the base station. The nodes which lie between 100 to 150 meters from the center point of the network is selected as ring nodes.

The next phase is associating the normal nodes to any one of the ring nodes using the following method. Each ring node will send a "hello" message indicating its presence at that particular region. Whichever normal nodes hears this message will mark itself as first hop node and will send its "hello" message indicating the same to other normal nodes. In this way the entire network nodes get associated with the nearest ring nodes based on the number of hops. Next is the communication between normal nodes and ring nodes. All the normal nodes will initiate communication with its ring nodes selected. Each node sends one packet to its ring node through the selected path i.e. in the shortest path possible to the nearest ring node.

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Followingis the selection of aggregator nodes among the ring node. Here it starts from the base station node. The ring is divided into two halves. The first ring node that can directly communicate with the base station is selected as aggregator node and all other ring nodes associate itself with anyone of the selected aggregator node in the same way normal nodes associated with ring nodes. That is the shortest path to reach any one of the ring aggregator node. Then the communication between ring nodes and aggregator nodes takes place. Each ring node sends one packet to its selected aggregator node using the shortest path it has selected. In this last step the aggregator node sends the collected data to the base station using direct communication as it can directly communicate with the base station.

V. RESULT AND DISCUSSION

The performance of Ring Routing with aggregator nodes under various parameters are simulated using Network Simulator 2 (NS2).

A topology of 100 sensor nodes are deployed in the area of 1000×1000 m2 in which 99 are the sensor nodes and the 100th node is the base station.

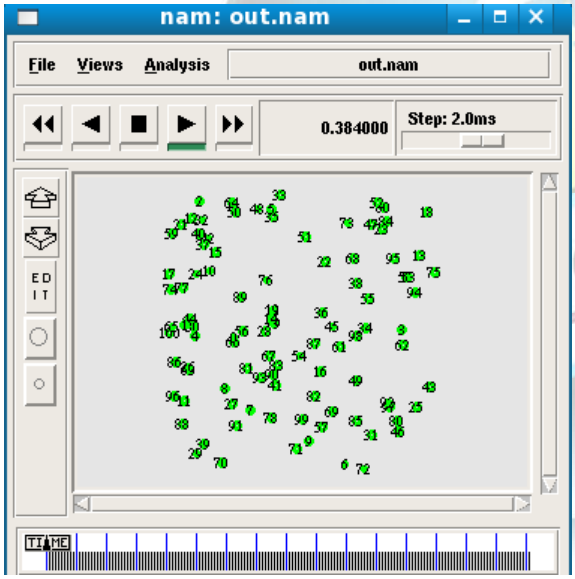

Figure 2. Sensor Network Topology

Figure 2 is the network topology of sensors which displays the NAM (Network Animator) window with 100 sensor nodes.

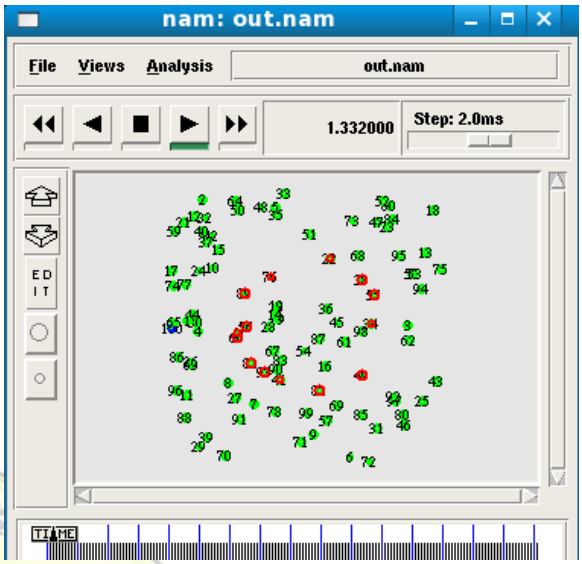

Figure 3. Selection of ring nodes and sink

Figure 3 shows the selection of ring nodes and the base station. Ring nodes are formed with the distance of 100 to 150 m from the center node at 500×500 m2. A static sink is placed in the sensor network. The node 100 is identified as the static node in the network.

Figure 4 shows the communication between the sensor nodes and ring nodes. The ring node advertises its position to other sensor nodes. Hence the sensor nodes attach to the ring node directly or by some other node and delivers data to the ring. This finds the shortest path to deliver the packets.

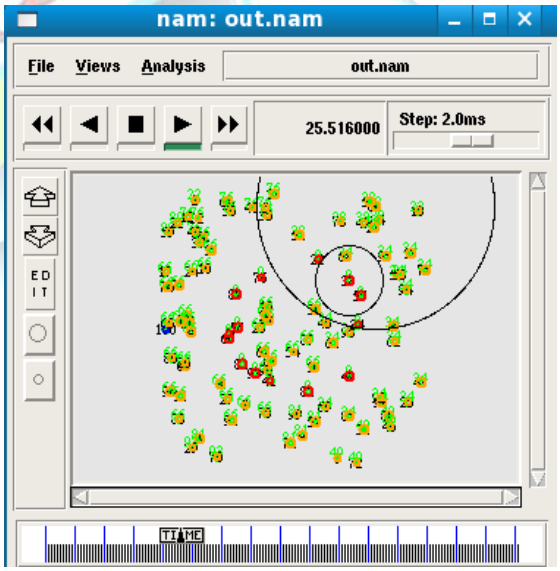

Figure 4. Communication between ring node and sensor node

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In Figure 5 the communication between the ring nodes and the aggregator node is displayed. The ring nodescommunicates with aggregators and transmits the collected data to aggregators.

Finally a communication between the aggregators and the sink or base station takes place where the collected data packets from the aggregator'smoves towards the base station of the sensor network.

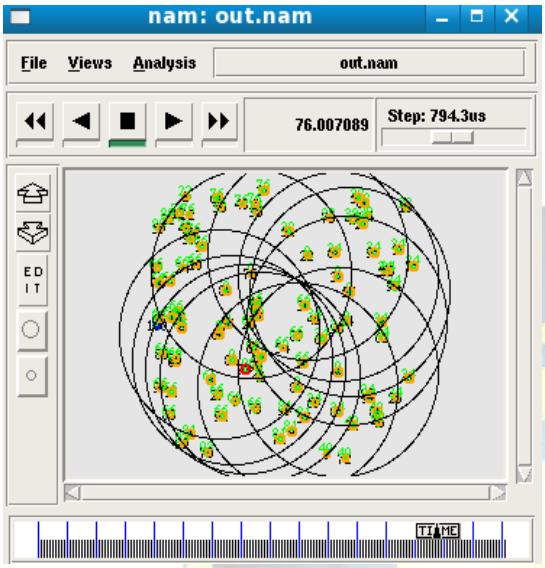

Figure 5. Aggregators and sink communication

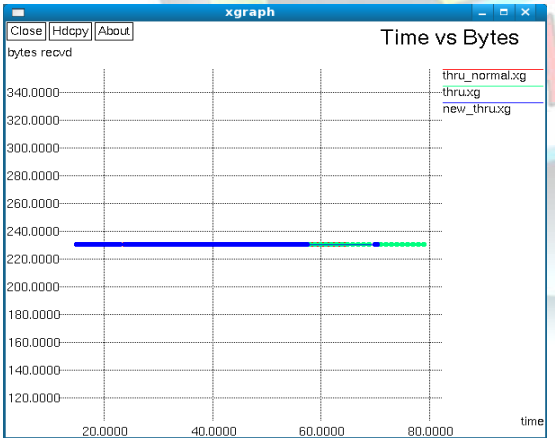

Figure 6. Time vs Bytes

Figure 6 displays that the aggregator nodes sends its data to the sink node in short span of time when compare to the ring nodes.

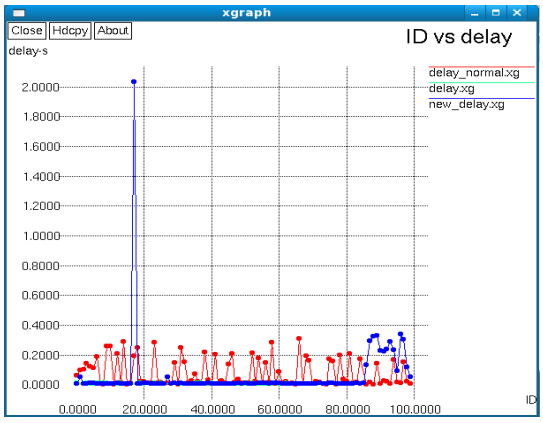

Figure7.ID vs Delay

Figure 7 shows the delay characteristics with respect to packet ID. Time taken for a packet to transmit its data with delay across a network is reduced when compared with ring topology.

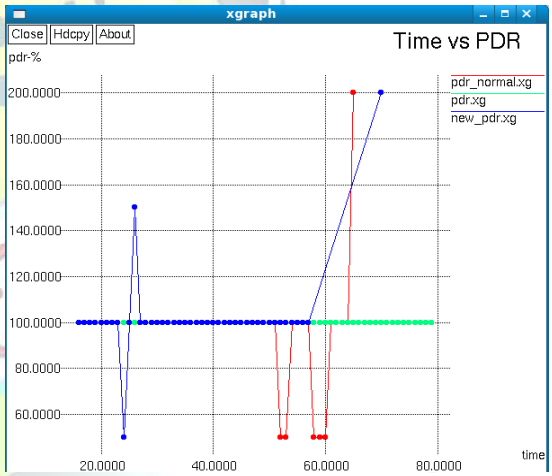

Figure 8.Time vs PDR

PDR (Packet Delivery Ratio) is the ratio of number of packets received to the number of packets send over a network. Figure 8 represents the higher PDR value within minimum time period.

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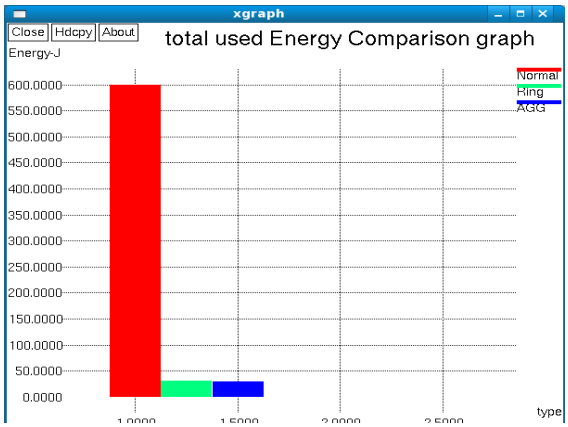

Figure 9. Total used energy comparisons

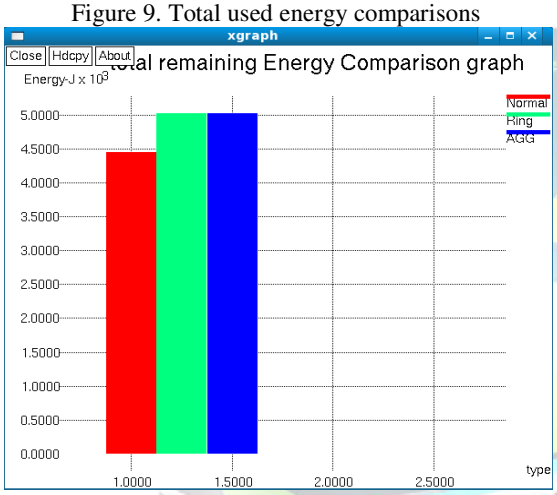

Figure 10. Total remaining energy comparisons

From figure 9it denotes that used energy in ring and aggregator nodes which is less when compared to normal node. Likewise in figure 10 the remaining energy in ring and aggregator will be more than the normal node.

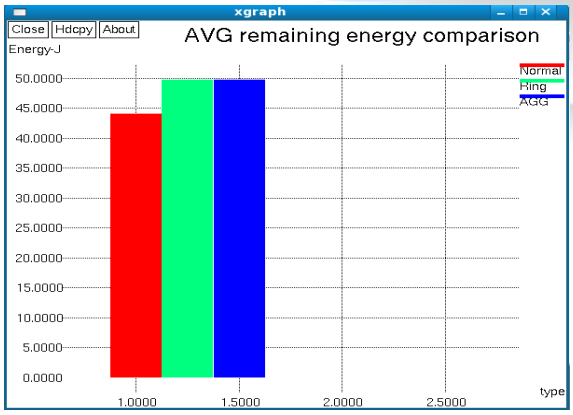

Figure 11. Average remaining energy comparison

From figure 11 it displays the average remaining energy. This is the ratio of energy remaining in each sensor node to the total remaining energy. It clearly states that aggregator nodes have more energy than the normal node.

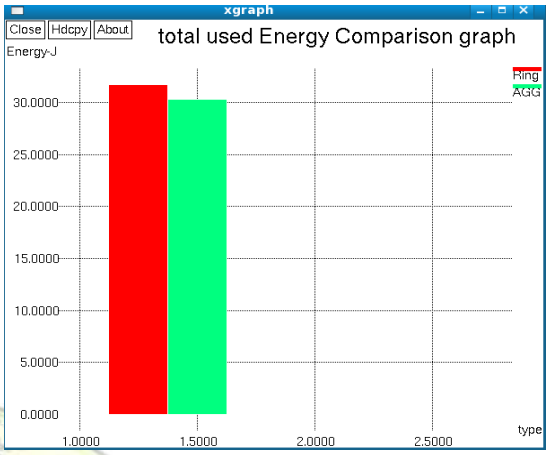

Figure 12.Total used energy comparison for ring and aggregator

Figure 12 gives the comparison graph of ring and aggregator nodes. From this graph it concludes that 1Joule of energy is saved through aggregator nodes.

VI. CONCLUSION

In this work, Ring Routing is achieved by the data aggregation technique. The aggregator nodes collects data packets from the ring nodes and those packets are collected by the sink. This improves the energy efficiency and reduces the data traffic in the network. From the simulation, it reveals that one Joule of energy is decreasedso that energy is saved by the aggregation technique but this point can be neglected when the time is compared as one Joule of energy does not make a big difference. In data aggregation technique time consumption is less when compared to Ring Routing technique.

Furthermore, time consumption also be taken as the important factor in wireless sensor network.Information sharing in a network is not safe because of intruders or malicious nodes. So that future work is to support time saving and the security with data aggregation.

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