ISSN:2231-0711

Divjot Kaur et al | IJCSET(www.ijcset.net) | May 2016 | Vol 6, Issue 5, 149-152

Energy Efficient Data Collection in WSN with Multi-Hop Routing

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***Abstract*— Wireless Sensor Networks (WSNs) are usually self-organized wireless Networks which consists of a number of smart sensor nodes working together in many applications of tracking & monitoring. The main tasks of these sensor nodes are: firstly, systematic collection of data and secondly, transmits gathered data to a distant base station (BS). Hence network life- time becomes an important parameter for efficient design of data gathering schemes for sensor networks. In this paper, we use multi-hop routing to transfer the data. In our proposed energy-efficient mechanism, the most appropriates nodes (Super nodes) for data forwarding will be selected and the lifetime of the whole network will be maximized. The simulation results show that by using the proposed approach, the lifetime and number of alive -nodes of the network will be increased.**

***Keywords*— Wireless Sensor Network, Data Collection, Energy Efficiency, Multi-hop routing,**

I. INTRODUCTION

Wireless Sensor Networks are used in a large variety of applications including military applications, environmental applications, health-care applications, home applications and other commercial applications. WSNs contain a large number of sensor nodes, which are tiny devices that work using a battery. These devices perform three functions: sampling a physical quantity from the surrounding environment, processing (and possibly storing) the acquired data and transferring them through wireless communications to a data collection point called sink node or base station. These WSNs contains huge set of small sensor nodes, deployed in the environment for monitoring environmental parameters such as humidity, temperature, pressure, etc. The wireless sensor nodes sense the data from environment based on the application and forwards to the central base station or sink for further processing. Figure shows the example of Wireless Sensor Network.

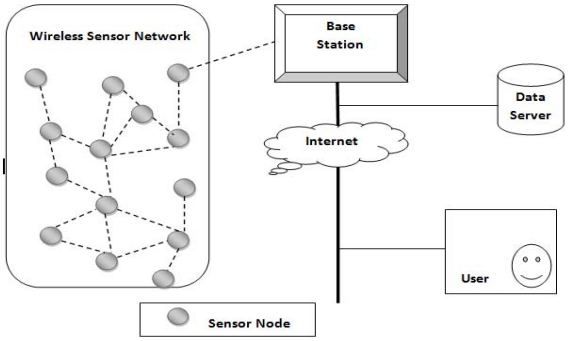

Fig. 1 Architecture of Wireless Sensor Network

II. DATA COLLECTION

Data collection is one of the most important operations of wireless sensor networks. Various data collection techniques designed for sensor networks and many practical applications require the real-time data transmission, such as controlling, tracking. Data collection process is performed by particular routing protocol. Our goal is gathering data to reduce the energy utilization. So sensor nodes are supposed to route packets based on the data packet content and select the next hop in order to promote in network gathering. Basically routing protocol is separated by the network structure, because of this reason, routing protocols is based on the considered approaches. Data collection techniques in Wireless Sensor Net-works (WSN) suffer from heavy congestion particularly at nodes closer to the sink node. In order to conflict this problem, either co complex MAC layer protocols have been proposed or non-scalable data collection solutions have been designed.

III. ENERGY EFFICIENCY

The very challenging requirement of WSN is energy efficiency, which depends upon the distributed design and dynamic topology of the network. This requirement can be fulfilled by the multi-hop energy efficient routing protocols. The objective of all the energy efficient protocols is to extend the network's lifetime. Sensor nodes are battery operated, so generally concern of all routing protocols is to conserve energy. The energy of the routing protocols is affected by the many factors and some are discussed as below:

- **Energy Expenditure in One round:** One round is defined as the execution of the protocol for one time in which data of all the sensor nodes is transmitted to the BS. This is the total count of the energy expenditure of all the nodes in one round.
- **Energy Consumption in Data aggregation:** It is defined as the depletion of the energy in aggregating data. Some routing protocols are multi-hop and they transmit their data through the CHs and data is aggregated at the CHs by the nodes. So CHs consume energy in this task and it depends upon the condition whether the data was already processed or still have to be processed by the CH.
- **Residual Energy Threshold:** It is the term which makes aware of the remaining energy of the nodes so that it could become easier to know how much load can be handled by the sensor node. Some Routing protocols

do not elect the sensor nodes as the CHs when their energy level is less than the threshold.

- **Lifetime of the Network:** It is defined as the time till the death of the last node of the network. Routing protocols use this factor to predict the total time of the execution of the network.
- **Total Energy Consumption by the Node**: Mainly energy of the node is depleted in the sensing, transmitting, processing and aggregation of the data. So energy cost of the nodes is computed in these terms.
- **Travelling Distance of the Data:** More energy of the sensor node is consumed if the packet has to be transmitted at the long distance that is why some protocols use the clustering scheme to reduce the communication distance among the nodes.

IV. MULTI-HOP ROUTING

Development of energy efficient protocols is the need of the hour. WSN is the energy constrained network due to the limited power, low memory, low processing battery operated sensor nodes. Routing protocols mainly considers the try to maximize the life of the WSN by developing the optimal shortest routing paths and by minimizing the data travelling distance among the nodes. To make the WSN work for several years, other issues are also considered like switching off the radio components of the nodes whenever they are not in use and nodes have to self organize to maximize the energy efficiency. The environmental conditions also affect these nodes where it becomes more essential to take necessary to develop the new routing algorithms. The main objective of routing is not only to transmit the data from the source station to destination but to perform this function in energy efficient way.

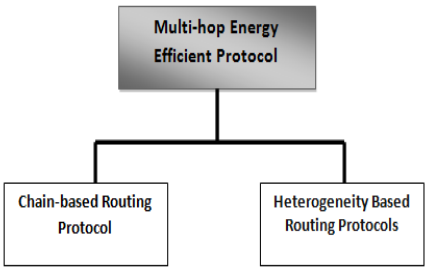

Fig. 2 Classification of Multi-hop routing

V. PROBLEM FORMULATION

In the WSN the major problem is to conserve energy and improve the network lifetime. In Wireless Sensor Network data collection process, the sensor nodes forward the data to the central base station either by direct communication or by multi-hop communication. The direct communication from sensor nodes to base station is energy expensive due the distance between sensor nodes and base station is more, this reduces the lifetime of the network. Alternatively, Multi-hop communication schemes are used for better network lifetime and performance due to its effective utilization of resources. To improve network lifetime and optimize throughput various protocol are design. Various protocols for example like LEACH (Low-Energy Adaptive Clustering Hierarchy), FCA (Formal Concept Analysis) is design to improve the network lifetime. But problem is arise LEACH are design as homogeneous network and cluster head are choose by randomly selection. But in FCA algorithm the network create as heterogeneous then there is also arise problem because normal node which those are nearest from sink node they can transfer data to sink node easily, but those node far from sink node they travel more distance to transfer the data then these nodes are consume more energy than those node nearest from sink node and these nodes has less lifetime. In our problem, the life time of network is depends upon the Energy Consumption, when the node is transfer data to another node then energy is consumed and network life time is decreased . In this work the proposed work is will be focus on improving the network lifetime. The problem of network is solved using Multi-hop Heterogeneous routing protocol including Super nodes. The multi-hop routing is suitable for increase the network lifetime and transfer more packets to sink node. We proposed a Multi-hop routing protocol based on Super nodes and analyse the results of proposed algorithm.

A. Methodology

Our main concern is with increase the life time of network. The energy consumption of each node is affected the lifetime of network. Initially the nodes are randomly deployed. Next choose the Sink node which placed at center of the normal nodes. Then select the area or region from the Sink node (select 30 m area from sink node) to select the nodes those included within this selected area. After choose the selected node increase the energy of these nodes than normal node and now theses nodes are called Super nodes. Next the remaining nodes are choosing cluster head according to probability function. Last the after choosing the cluster heads remaining nodes are called normal nodes. Finally the network architecture is ready to communication. The normal nodes are transferring the data to cluster head these normal nodes choose nearest cluster head. These nodes only transfer to cluster head. After receive the data cluster head s send data to nearest Super node then super node transfer the data finally send to sink node. This network is used Multi-hop routing means the normal node don't send the data directly to sink node. So, the normal node consumed less energy when these nodes send data and its life time also increased. The following diagram is used to explain this scenario.

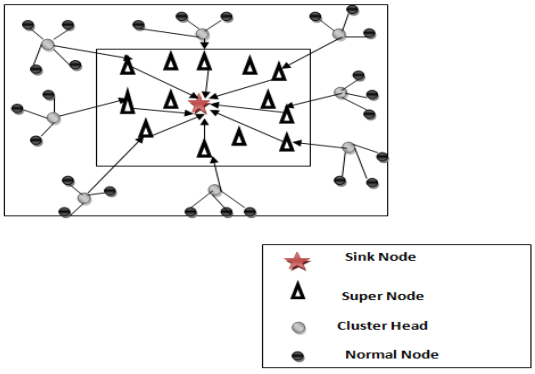

Fig. 3 Proposed Architecture of Network

B. *Flow Chart of Proposed Methodology*

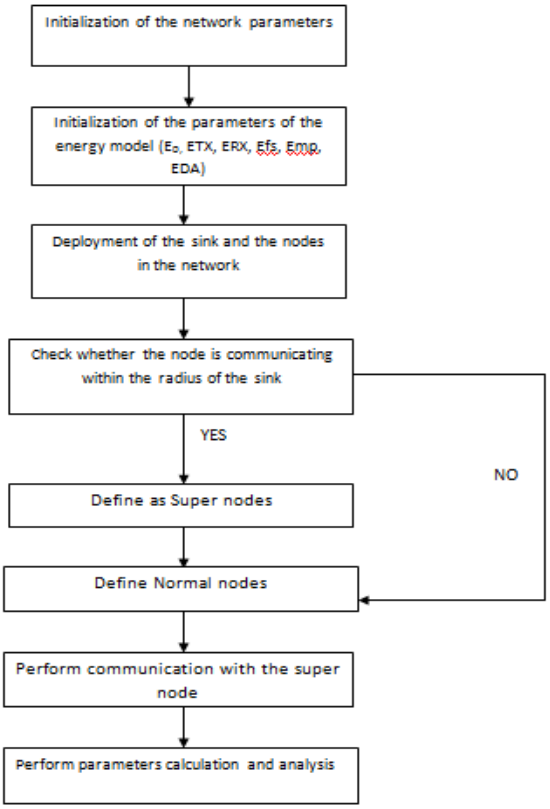

Fig. 4 Flow Chart of proposed Methodology

VI. RESULT ANALYSIS

In following figure we can compare proposed technique with traditional technique. Various comparison parameters are used to show the compare like: no. of dead nodes, no. of alive- nodes and residual energy. In following all figures the blue line show traditional technique results and red line show results of proposed techniques. The following screen shorts represent the compare:

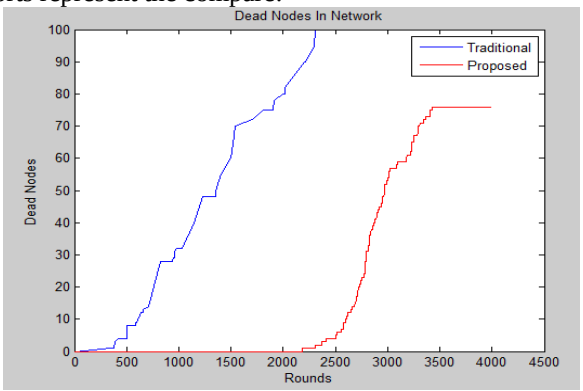

Fig. 5 Representation the comparison of dead nodes between traditional and proposed technique.

In above figure 5 the x-axis shows no. of rounds and y-axis shows no. of dead nodes. The results are shows in traditional technique the nodes are early start to become dead nodes as compare to proposed techniques.

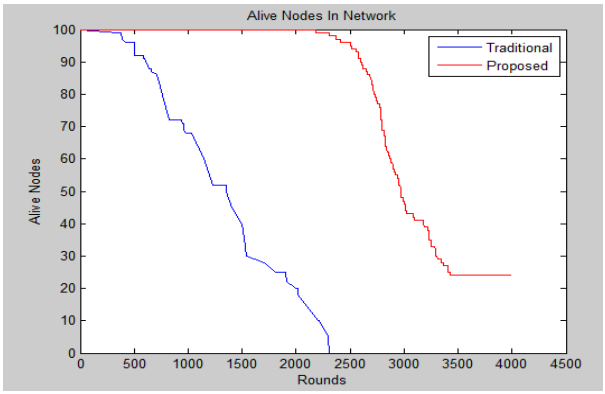

Fig. 6 Representation the comparison of alive nodes between traditional and proposed technique

In above figure 6 the x-axis shows no. of rounds and y-axis shows no. of alive- nodes. The results are shows in traditional technique all nodes are dead after complete some rounds as compare to proposed technique but in proposed technique maximum rounds are covered.

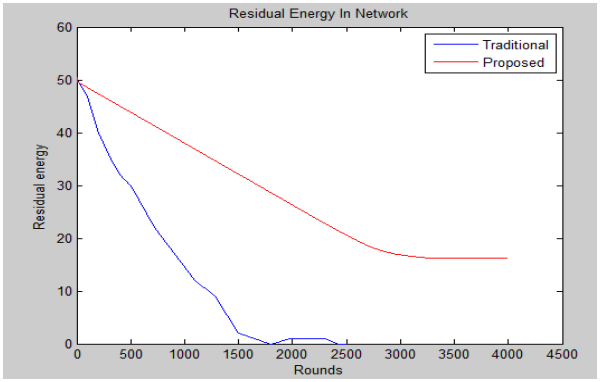

Fig. 7 Representation the comparison of residual energy between traditional and proposed technique

In figure 7 the x-axis shows no. of rounds and y-axis shows residual energy which consumes for transfer the data. The result shows the traditional technique can consume more residual energy for data transfer rather than proposed technique.

VII. CONCLUSION

In the result analysis, the deployment of 100 nodes and 45000 rounds is shown. In Wireless Sensor Network data collection process, the sensor nodes forward the data to the central base station by using multi-hop communication. We compare the results of proposed technique by taking dead nodes, alive nodes and residual energy versus number of rounds. It is clear from the simulation outcome that in WSNs, by using the multi-hop routing for data collection on sink it is possible to enhance the network life time and also efficiently balance the energy consumption load across the network. The energy consumption of the network becomes uniform. That mean the proposed technique is efficient than the other traditional technique of data collection.

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