OPTIMIZATION OF ENERGY EFFICIENCY USING CLUSTER TREE BASED DATA AGGREGATION TOPOLOGY FOR WIRELESS SENSOR NETWORKS

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ABSTRACT: Wireless sensor networks are mainly used in many applications like military applications, home automation, agriculture, finding temperature, finding humidity of soil, monitoring traffic, vehicular tracking etc. Energy conservation is one of the major issue need to be considered for the better performance of the network. Therefore in this paper, an efficient cluster tree based topology is defined for preserving energy, which is named as Energy Efficient Cluster Tree Topology (EECTT). In this method, we define special nodes called Data Collection Nodes (DCN) which are mainly used for collecting data from cluster heads aggregates the data and forwarding to the sink. Aggregation is done to use energy efficiently. Next Data Collection Tree (DCT) is constructed from DCN nodes thereby reducing the energy consumption. Simulation results shows that the defined cluster tree based method provides better QoS (Quality of Service) in terms of energy consumption, throughput and delay for Wireless Sensor Networks (WSN).

KEYWORDS: Wireless Sensor Networks, Data Collection Nodes, Data Collection Tree.

INTRODUCTION

Wireless Sensor networks have wide variety of applications and they are mainly used to monitor physical or environmental conditions. A WSN is consists of number of sensing nodes deployed in the network area and one or more base stations connect a network. Each sensor node consists of processing unit, memory, and a power source like batteries. These nodes sense, process and transmit information to the base stations. Sensor nodes have the capacity of sensing the environment. Since it has limited energy, design of routing protocol and network topology are most important. The effectiveness of the WSNs depends on their sensing quality, energy consumption, mobility, network lifetime, scalability etc. Data collection methods are important factor in determining the performance of WSNs. Topology management plays a major role in reducing many constraints such as limited energy, node failure, delay, traffic, etc. Topologies define the types of routing path, and it determines the size, type of packets. Therefore selecting an efficient topology helps to enhance the performance, coverage, lifetime of the network and QoS of the network.

RELATED WORK

The existing topologies based on the data gathering are flat, chain, tree, cluster topologies. Flat Topology (FT) is one of the simple methods to gather data and it does not have predefined topology. Therefore it cannot provide energy conservation mechanism. In Chain Topology (CT) nodes are constructed in the chain manner and one node is selected as leader and the remaining nodes can communicate along the chain path. This topology suffers from excessive delay from the distant nodes. Cluster Based Topology (CBT) is one of the method widely used in WSN in which nodes are grouped into clusters but it cannot offer guaranteed data transmission rate. LEACH (Low Energy Adaptive Clustering Hierarchy) is one of the popular clustering method in which cluster heads are selected randomly. This method select the cluster heads based on threshold value. This method is not suitable for large WSNs and creates overhead because of dynamic

clustering. In LEACH protocol, all the nodes in a cluster can become Cluster Head after certain period of time. Tree Based Topology (TBT) constructs a logical tree for nodes but it cannot tolerate node failures and energy consumption is uneven across the network. Therefore in order to overcome the existing limitations we define a cluster tree data collection mechanism named as EECTT (Energy Efficient Cluster Tree Topology).

EECTT DESIGN

The EECTT (Energy Efficient Cluster Tree Topology) Design consists of two phases namely setup phase and steady state phase. In the setup phase formation of cluster and formation of DCT is done. In the next steady state phase data transmission is done. System architecture is designed as shown in figure 1.

Figure. 1. System Architecture

Setup Phase

In the setup phase first sensor nodes deployed over the network region in rectangular fashion. Once the nodes are deployed each node calculates the neighbor node distance and coverage distance between all the nodes. Then clusters are formed based on the RSS (Received Signal Strength). Depending on the RSS value nodes which falls under this RSS value are grouped into one cluster and this process is repeated until all the clusters are formed. After forming the clusters, Cluster Heads are selected based on the three parameters namely RSS, residual energy and connection time. In a cluster, node which is having highest value of residual energy and lowest value of RSS, connection time is considered as CH and this process is repeated among all the clusters to find CHs. After forming the cluster head DCT formation is initiated. In DCT formation, first DCN are selected. Data Collection Nodes are selected in such a way that node having the second highest weight in a cluster. After forming the DCN nodes construction of DCT is initiated. DCT is formed in such a way that all DCN nodes are connected in a tree fashion in which DCN nodes send the data to the sink node. Initially sink starts finding first DCN which near to the sink node (i.e. one-hop distance from the sink). Next, tree construction continues by finding the next hop DCN node and finally all the DCN nodes are connected in tree manner. Cluster formation is as shown in the figure 2. After forming the clusters, Cluster Heads and DCN nodes are selected as shown in the figure 3.

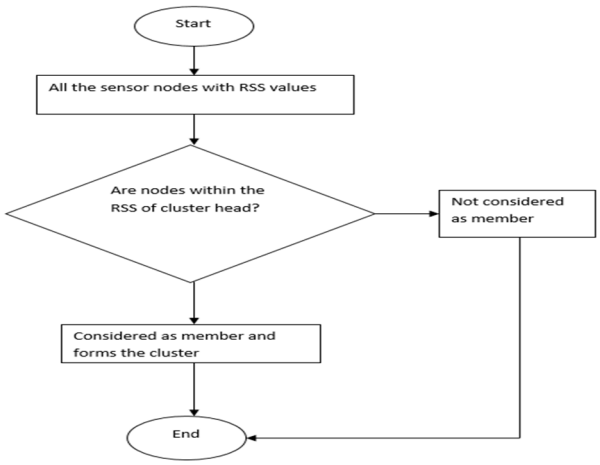

Figure. 2. Flowchart for Cluster Formation

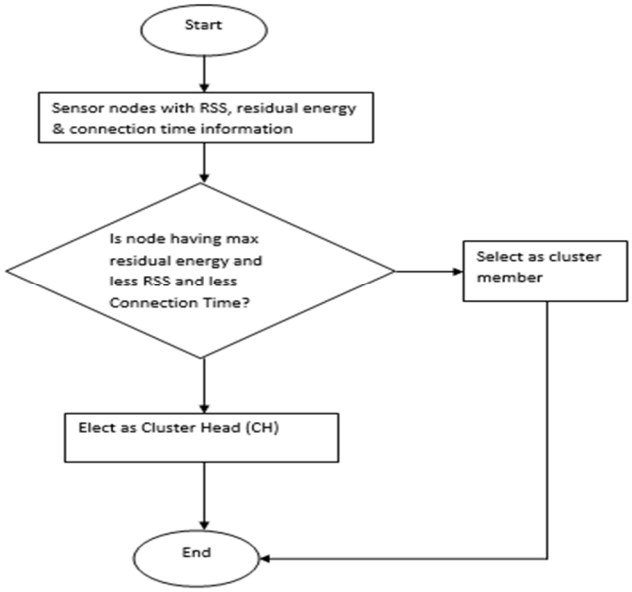

Figure. 3. Flowchart for Cluster Head Selection

Steady State Phase

Once the setup phase has been completed, steady-state phase is initiated. In steady state phase, data transmission is initiated. First, all the cluster members send the data to the respective cluster heads. After cluster heads collect the data from cluster members, it sends the data to the respective DCN nodes. Then DCN nodes send the aggregated data to the sink through the Data Collection Tree. In this way data is transmitted to the sink node.

Algorithm for the proposed system

1. Initialize network parameters to deploy the nodes.
2. Form the clusters based on RSS values.
3. Select Cluster Heads based on Residual energy, RSS and connection time.
4. Extract residual energies of nodes from Trace file T_i
5. Get node ID, node residual energy E_i from T_i.
6. Calculate the coverage distance between nodes using $d_{opt} = \sqrt{(x2 - x1)^2 + (y2 - y1)^2}$
7. Get RSS for all the nodes.
8. Get Connection time t_i for all the nodes.
9. For node N_i
10. If (E_i is high && RSS_i is less && t_i is less)
11. N_i becomes CH.
12. If (E_i is high && RSS_i is less && t_i is less) value is second highest.
13. N_i becomes DCN.
14. CH receives data from Cluster members.
15. CH forward data to DCNs.
16. DCN forward data to the base station.

IMPLEMENTATION

Network Simulator (NS-2) is used for the simulation to study the performance of proposed system and comparison between existing and proposed system is done. We considered one existing method CTDGA (Cluster Tree Data Gathering Algorithm) to compare with the proposed EECTT method. Since CTDGA is also one of the existing Cluster Tree based topology, we considered this method for the comparison. A WSN comprising of 82 nodes considered in the simulation scenario. All the nodes were randomly deployed in the network region. Figures 4,5,6,7 show the simulation scenarios.

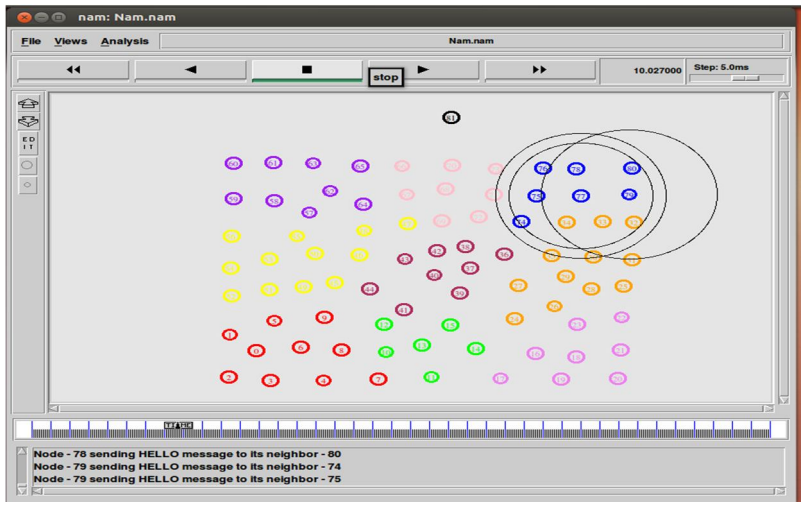

Figure. 4. Cluster formation

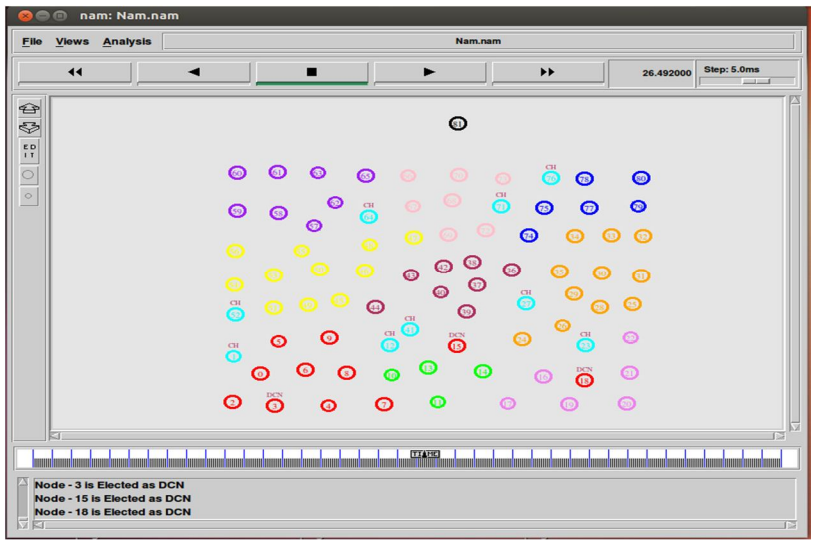

Figure. 5.CH and DCN node formation

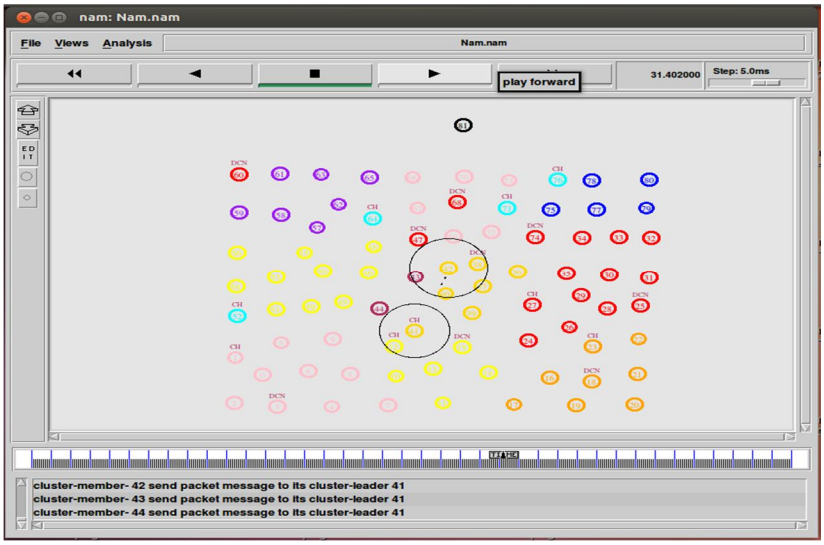

Figure. 6. Data Transmission from cluster members to CHs

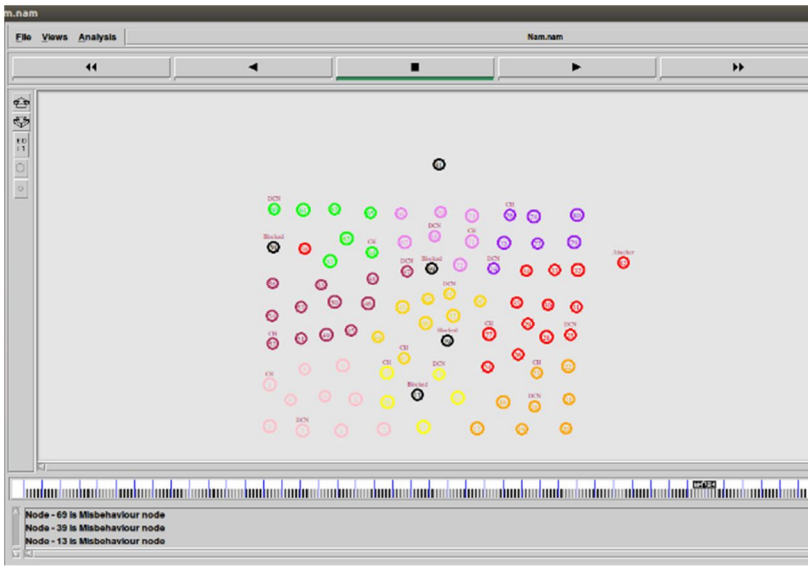

Figure. 7. Node failure

Figure 8.Shows the performance of EECTT with CTDGA algorithm in terms of PDR (Packet Delivery Ratio). In the graph it is shown that EECTT is able to achieve better performance than the existing algorithm in terms of PDR because the proposed system able to provide considerably stable links and reduces packet overhead of CH and DCT offers less traffic between CH and the sink.

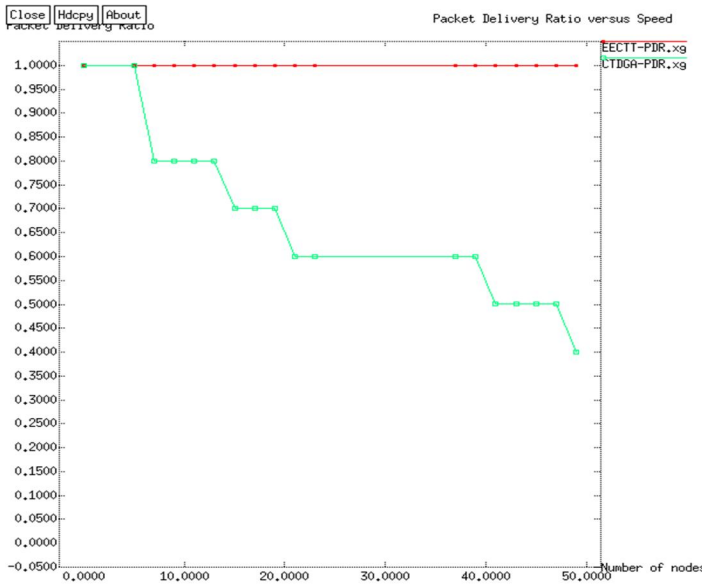

Figure. 8. PDR vs. No. of nodes

Figure 9shows the performance of EECTT in terms of throughput. In the graph it is shown that EECTT is able to achieve better performance in terms of throughput because EECTT offers minimum load and DCT selects an optimal link between CH and sink.

Figure 10 shows the performance of EECTT in terms of energy conservation. In the graph it is showed that EECTT is able to save considerable amount of energy when compared to the existing protocol CTDGA because it selects the CH with better coverage distance, maximum residual energy and better RSS value thereby reducing the total energy consumption for the entire network.

Figure 11 shows the performance of EECTT in terms of delay. In this graph it is showed that EECTT has minimum delay when compared to the existing protocol CTDGA because the EECTT method finds shortest path to transfer the data and provide stable links. Finally all the graphs shows that proposed method gives better performance than existing method in terms of PDR, throughput, energy and delay.

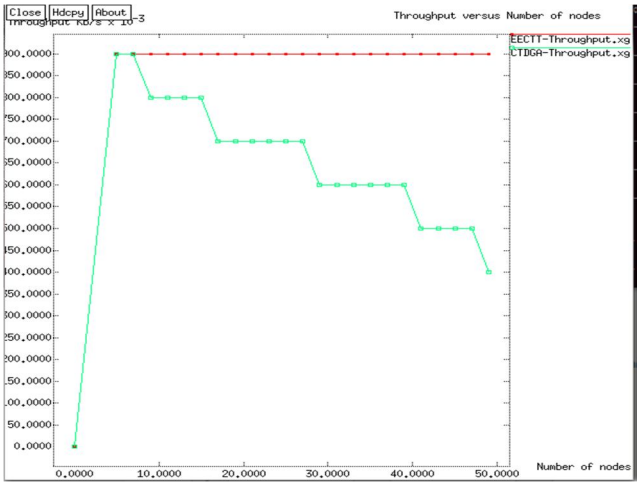

Figure. 9. Throughput vs. No. of nodes

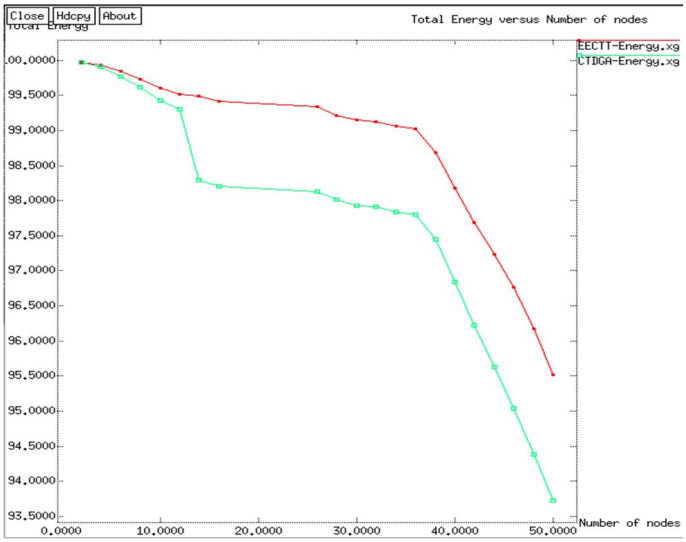

Figure. 10. Total Energy vs. No. of nodes

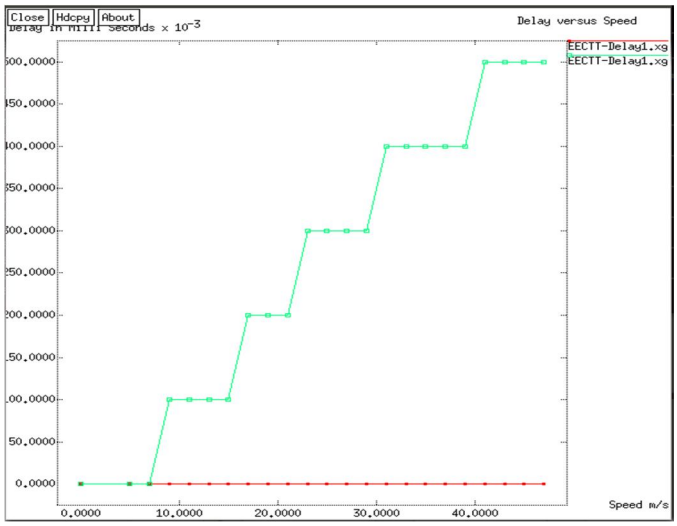

Figure. 11. Delay vs. Speed

CONCLUSION

In this paper, EECTT an efficient method is proposed to construct a WSN to improve the performance. In this method cluster tree based topology is used and DCN nodes are defined to reduce the overhead on Cluster Heads thereby increasing the energy efficiency of the network. From the simulation results, it is showed that EECTT method provides better throughput, increased energy utilization and PDR with reduced traffic than the existing protocol. In the future work, failed node will be made as active nodes after some time by considering few criteria.

REFERENCES

[1] Priyanka.P & Ayyappan.B; (2015); *"Wireless Sensor Networks – Technologies, Protocols, Applications and Simulators: A Survey"*; ICON-STEM;
[2] Selvakumari.P & Balaji.G; (2014); *"Energy Efficient Method Using Energy Balanced Routing Protocol for WSN"* ;IJARECE.
[3] Gurwinder Kaur & Rachit Mohan Garg; (2012); *Energy Efficient Topologies for Wireless Sensor Networks*;IJDPS; Vol.3; 5.
[4] Lalita Yadav & Ch.Sunitha; (2014); *Low Energy Adaptive Clustering Hierarchy in Wireless Sensor Networks(LEACH)*; IJCSIT; Vol.5;3; 4661-4664.
[5] Heena Dhawan & Sandeep Waraic; (2014);*A Comparative Study on LEACH Routing Protocol and Its Variants in Wireless Sensor Networks: A Survey*; IJCA; Vol. 95;8.
[6] R. Elankavi & R. UdayKumar; (2013); *Data Collection in Wireless Sensor networks – A Lliterature Survey*; IJIRCCE; Vol.1.
[7] R.Velmani & B. Kaarthick; (2015);*An Efficient Cluster Tree Based Data Collection Scheme for Large Mobile Wireless Sensor Networks*; IEEE SENSORS JOURNAL; Vol. 15;.4.