Enhance Throughput in Wireless Sensor Network Using Topology Control Approach

Parikha Chawla, Parmender Singh, Taruna Sikka

Abstract: ***This paper is associated with implementation of topology control approach to enhance throughput in wireless sensor network. A wireless sensor network is characterized by limited energy supply and large nodes. To maximise the network lifetime of wireless sensor network the topology control is the considered to be the important process. Every attempt is being made to reduce the energy consumption and to enhance throughput of the wireless sensor node. Topology Control aims at network-wide goals, for example, extending network-lifetime minimizing average delay. Network topology control is about the management of network topology to support network-wide requirements. Topology Control Algorithms can be divided into transmission-power-based algorithms and duty-cycle-based algorithms according to their energy saving approaches. Two energy efficient topology control algorithms will be used by utilizing both clustering and adjusting transmission power.***

Index Terms- algorithms, clustering throughput, topology control, sensor network, wireless

I. INTRODUCTION

A Wireless Sensor Network consists of a large number of low-power, inexpensive, unobtrusive sensor nodes and is deployed in environments of interest or embedded into ordinary objects for monitoring habitats, tracking objects and, processing collected information [1]. A sensor network is composed of a large number of sensor nodes, which are densely deployed either inside the phenomenon or in its proximity. A wireless sensor network is a new information acquirement system, it is considered to be one of the cutting edge technologies that would have great impact on human development in the era of 21st century.

Wireless Sensor Networks have become an emerging technology that has a wide range of potential applications including environment monitoring, object tracking, scientific observing and forecasting, traffic control and etc [2]. It can provide us real time data in a hostile environment at high fidelity over years and enable us to respond promptly. In WSNs, hundreds or thousands of sensor nodes are often randomly deployed in inaccessible areas where battery cannot to be recharged or replaced, and these sensor nodes communicating with each other through radio collect information or data for a base station. Since the sensor nodes are often inaccessible, the lifetime of a sensor node must be assured [3]. Lifetime of the sensor node depends on the lifetime of power resources. Therefore the topology control algorithms must be designed to be energy efficient to maximize network lifetime [4]. One of the key challenges is conserving energy so as to maximize their post deployment active lifetime. Large amount of energy saving schemes are presented in various aspects in the references. However, energy saving is not the only target the quality of service of wireless sensor is one of the most important aspects. If the sensor nodes consume energy equally, the chance that some nodes use up their energy much earlier becomes lower, and then the lifetime can be prolonged [5]. It is widely accepted that the approach of balancing energy consumption is an important way to guarantee the various quality of service requirements in wireless sensor nodes. Several schemes are presented for a cluster head to select nodes in the cluster to sleep so as to extend the network lifetime and reduce energy consumption of the entire cluster while keeping a certain fraction of the sensors energy-balance.

II. TOPOLOGY CONTROL APPROACH

Topology Control as one of the main ways to control energy consumption in Wireless sensor networks has been the focus of this paper. Topology control in network is about the management of network topology to support network-wide requirements. Topology Control and Quality of Service are closely related. On one hand, Quality of service has to be satisfied on network connectivity, sensing coverage, communication delay, network throughput, and network responsiveness[6]. On the other hand, topology control algorithm should reduce energy consumption to extend the network lifetime Topology Control Algorithms can be divided into transmission-power-based algorithms and duty-cycle- based algorithms according to their energy saving approaches in topology control.

Clustering as a very promising energy saving technique can be used with either a transmission-power-based algorithm or a duty-cycle-based algorithm. Clustering is a technique used in networks to divide nodes into two categories, cluster nodes and normal nodes[4]. Each normal node can directly communicate with at least one cluster head, and the cluster head usually takes more responsibility. Connected Dominating set is a special cluster structure where the cluster heads form a connected network without using gateways. Cluster-based routing protocol for wireless sensor network which partitions the nodes into clusters, in each cluster a dedicated node with extra privileges called Cluster Head (CH) is responsible for creating and manipulating a TDMA(Time division multiple access) schedule and sending aggregated data from nodes to the BS

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where these data is needed using CDMA(Code division multiple access). Remaining nodes are cluster members. The clustered network structure is shown in figure 1 where cluster head (CH) is connected to cluster nodes and to base station to transmit the data. Another aspect of topology control is that it aims at network-wide goals, for example, extending network- lifetime, guaranteeing network throughput, minimizing average delay etc.

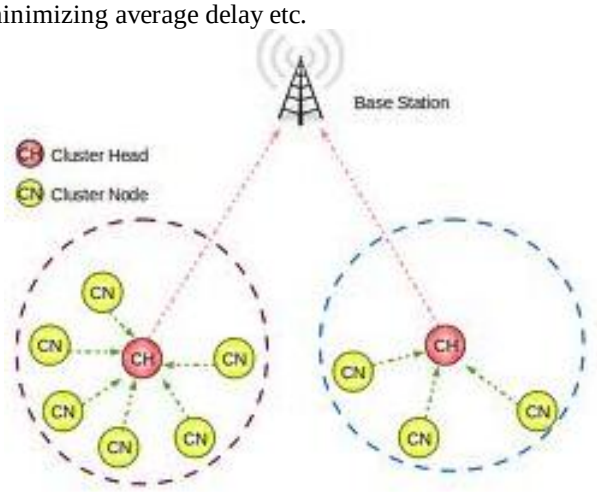

Fig. 1 Clustered Network Structure

Network Topology Control Algorithms have to be energy-efficient, application-oriented, and executed in a distributed manner. A self-adaptive clustering algorithm for network topology control is proposed in which the cluster structure can be adjusted automatically according to the nodes distribution and network traffic [8]. Active sensor nodes and wireless connections among them define the network topology. Different applications have different network topology requirements for broadcasting and unicasting. Due to the limited power supply in nodes, topology control algorithms should reduce energy consumption as much as the application follows. Due to the lack of infrastructure and the ad-hoc characteristics in wireless sensor networks, the network topology should be computed and maintained in a distributed manner, use only local information, and be able to accommodate network changes.

III. CLUSTERING PROTOCOL

In the clustering routing algorithms for wireless networks, LEACH (low-energy adaptive clustering hierarchy) is well-known because it is simple and efficient. Low Energy Adaptive Clustering Hierarchy is a distributed clustering protocol which utilizes randomized rotation of local CHs to evenly distribute energy utilization between the nodes of sensor network [9]. The frame structure of LEACH protocol is shown in figure 2 where the whole operation of the protocol is divided into rounds. Each round consists of

a) Set-up phase (clusters are organized)
   Cluster Head Selection.
   Cluster Formation.
b) Steady state Phase (data transmission)

Set-up phase:

- Each node decides independent of other nodes if it will become a cluster head or not. This decision takes into account the higher probability of the node depending on the energy level.
- These head inform their neighborhood with an advertisement packet that they become cluster head.
- Non-cluster nodes pick the advertisement packet with the strongest received signal strength
- The member nodes inform their head that they become a member to that cluster with "join packet" contains their IDs using CSMA.
- Based on all messages received within the cluster, the CH creates a TDMA schedule, pick a CSMA code randomly, and broadcast the TDMA table to cluster members.

Steady- state phase:

- Data transmission begins; Nodes send their data during their allocated TDMA slot to cluster head.
- This transmission uses a minimal amount of energy (chosen based on the received strength of the cluster head advertisement).
- The radio of each non-CH node can be turned off until the nodes allocated TDMA slot, thus minimizing energy dissipation in these nodes.
- When all the data has been received, the CH aggregate these data and send it to the base station using a fixed spreading code and CSMA

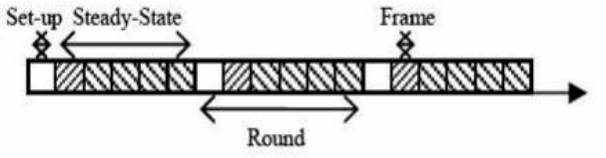

Fig. 2 Frame structure of leach protocol [11]

IV. PROBLEM FORMULATION

Previous work has been done on assigning minimum possible power to nodes & to activate only one path in specific time interval and deactivate other k-1 paths based on QoS parameters [5]. It has huge impact on the network lifetime and this method leads to reduce in consumed energy but increase the passage of time. Also if a distributed algorithm for power saving is employed, in which all the nodes use the same transmission power for communication, and the nodes make their local decisions on whether to enter into power-saving or active mode, the algorithm does not guarantee a connected active subnet work.

Now, two approaches

- Duty-cycle based algorithm
- Transmission-power based algorithm

are used having different network conditions. By dynamically integrating the two approaches, develop a two level topology control strategy to achieve further energy saving. It is one of the efficient approaches to save energy and keep network functionality by keeping cluster heads active and turning other nodes into the state of low duty cycle.

In wireless sensor network, clustering can be used with a transmission-power based algorithm to allow the normal nodes to use just enough

transmission power to reach a cluster head or used with a duty-cycle based algorithm to turn normal nodes into a low duty cycle, both for energy saving. Optimal transmission range problem in clustered wireless sensor network also gets minimized. Total energy consumption can be estimated on traffic pattern, energy and network deployment parameters especially,

Connecting Dominating Set based clustering algorithm is used for desired connectivity among the cluster heads [12]. Adaptive topology control algorithms update the transmission powers or duty cycles based on some continually changing conditions.

V. METHODOLOGY

Parameters for simulation

E_{elec}= Energy required in sending or receiving 1bit

k = the amount of data sent by nodes each time

E= the initial energy of every node

EDA= Energy consumed in every bit data fusion

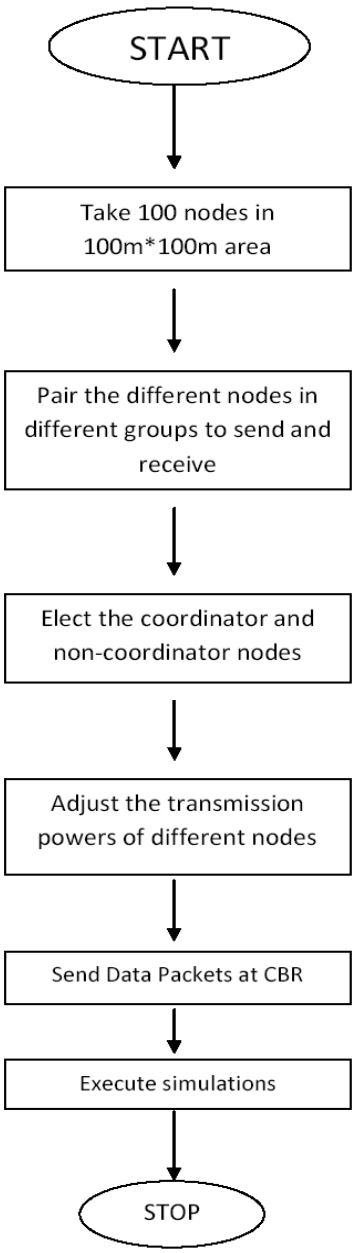

Fig. 3 Flow chart of topology control algorithm

In the first step nodes are taken in rectangular area of $100m^2$ let us 100 nodes are taken.

- In this way various nodes in different groups are paired to send and receive packets and transmission power of these different nodes is adjusted in which coordinate nodes and non-coordinate nodes are elected
- Execute the simulations in networks with different node densities to note the desired throughput of the topology.

VI. CONCLUSION

In this paper we have surveyed recent research works which mainly focuses on the energy consumption and enhance throughput in wireless sensor network for which topology control approaches are implemented using different algorithms. The ultimate objective behind these approaches is to reduce energy consumption and to extend the network lifetime of desired network topology. Above proposed methods are used to enhance the power and throughput among the nodes in a wireless network in any kind of network topology it implemented.

Suggested topologies algorithm implemented on MATLAB R2009a simulation software, leading software packages for numerical computation. At last not the least we conclude that the power consumes and throughput are the keynotes in the wireless network especially in adhoc network. The proposed work will increase the network lifetime with some intelligent cluster selection approach.

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