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ENERGY-AWARE VIRTUAL BACKBONE TREE CONSTRUCTION ALGORITHM FOR DYNAMIC WIRELESS NODES AND MEASURED IN TERMS OF ENERGY CONSUMPTION LEVEL

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Keywords—Sensor networks, Multicasting, Energy, Overhead

Abstract

Wireless sensor network works on a low-energy, low-cost basis and the nature of cost of composite systems and gathering real-time information by tiny nodes take place through a number of potential applications; a great deal of attention is gained by the network through multicasting and routing. This paper proposed energy aware virtual back bone tree algorithm to create wireless nodes from dynamic situation based on the energy levels. The wireless nodes are creating virtual backbone to establish the communication between the nodes. The NS2 simulation results outperformed in terms of average energy consumption and reduced control packet overhead.

Keywords—Sensor networks, Multicasting, Energy, Overhead

I. INTRODUCTION

Wireless sensor networks (WSN) is involved in 100s of components which are very potential such as sensing and processing and 1000s of tiny, low cost and low power self-organizing communications. Sensor nodes perform various functions based on the networks, their role vary widely depending on the field involved. With regards to terrestrial wireless, there is a complex distribution of sensor nodes inside the network, while the nodes are dispersed and arbitrary. The sensor nodes are monitored in a pre-planned manner into the area of target. They function cooperatively in varying environments and only limited battery power is required in this network.

WSN is a network which is made up of distributed independent devices which can audit the ecosystem. In general, WSNs are used to monitor the environment, ecosystem, predicting and detecting natural disasters, medical monitoring and also structural health monitoring. It is made up of a huge number of tiny, less expensive, disposable and independent sensor nodes which are deployed generally in a random manner in large geographical areas to be operated remotely. There is severe restriction of sensor nodes in terms of storage resources, computational capabilities, communication bandwidth and supply of power. A typical sensor node is made up of clusters and there is a node in each cluster which is called the cluster head (CH) as shown in the proposed fig (1) [1].

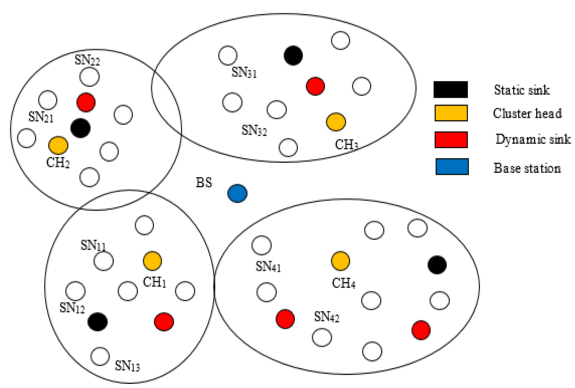

Fig. 1. Proposed topology

II. LITERATURE SURVEY

All the data packages need to be encrypted with that of a shared group key which is prior to the transmission. The users that have shared key will decrypt such packages and also access its data. The designing of the secured key management schemes will need a secret for the purpose of setting up a relationship of trust among two or more parties for communication. Therefore, the communication between the members in the group will be secure.

It is quite vital to any network management, secure end-to-end communications should be provided between sensors, clusters and sinks and this holds good for WSN also. There are a few basic steps followed to ensure security in a network. The first is that through encryption information can be effectively and securely protected i.e. every message should be encrypted through a group key (GK). Only the legal group members have access to GK. The second step is that when nodes join or leave a group, GK should be changed. By changing GK, new members cannot access the network with the old GK and also leaving or expelled member cannot access the subsequent messages. The third security challenge is that there should be balance between security and limited resources of sensor [2].

The next important idea is distributing various keys to different sensor for retaining links. The distribution is done by a differentiated key pre-distribution which is proposed so as to improve the flexibility of certain links in a network. By extending well-known location centric (GPSR) and data centric (minimum hop) there is implementation of end-to-end secure communication protocol with minimum values for designing parameters [3].

The next challenge in security is to control entry to the data that is transmitted. The scheme of key management is classified into homogenous and heterogeneous environment. The objective of this paper is application of group key management with heterogeneous multiple group. The events involved in membership change can be handled through less storage, communication and computation cost. Authentication to messages is also offered in this scheme which is communicated within and among the groups [4].

Among the various operations in the SN the communications of the radio will consume most of the energy and the wireless routing protocols that are energy optimized will be crucial for the maximization of the lifetime of any sensor network. Even though it is possible to be able to employ the protocols of the ad hoc network which are normally unsuitable owing to various reasons: (1) the SNs have been deployed in a dense manner and are prone to the failures; (2) the SNs have only limited power, capacities of computation and their memory; (3) A cooperative effort of various SNs will be a unique feature in that of the sensor networks that are not normally encountered in the network environments that are ad hoc (4) the Sensor networks will normally be data centric. The routing strategies will normally be adopted in the sensor networks [5] which are as follows: the maximum power routing available, the minimum consumption of energy, the minimum routing and the power routing in which the route that is along with which there is a minimal power that is available of the other routes that are needed.

The main issue that is present in this is at the time of transmission of data from one of the SNs to that of another and this will take several more hops for reaching the CH/other types of SN/BS and therefore this energy will be drained to the maximum extent. In order to retain the CH and its energy the technique of scalable key management that is cluster based and energy efficient will be used. For the purpose of retention of the CH energy, the cluster-based key management technique has been proposed with that of the mobile sinks for the purpose of increasing the lifetime of the CH that can increase the network lifetime. Further, the routing path can also differ at the time of data transmission which happens from the sensor to that of the BS.

In case, the path is long the SN that is involved in the data transmission is made and the process gets repeated leading to depletion of energy. The network and its lifetime also increase if the route for transferring the data is found to be optimal.

In many such applications of the WSNs, and the data that has been collected is on the basis of a phenomena that is common and therefore has a very high chance of having some amount of redundancy (or even correlation) and owing to the correlation that is present in the readings of the sensors it will be expected that these approaches to communication will consider the correlation or the aggregation of data and the in-network processing that will outperform all the traditional approaches. The actual idea behind the data aggregation will be to combine the data that comes from various sources (the SNs) in some points of aggregation or the aggregators, the en-route, and will eliminate the redundancies by means of a simple processing in some points even before forwarding the data to that of the external BS [6].

The removing of such redundancies will result in the transmission of the number of bits and will reduce the consumption of energy and will increase the life time of the SNs. There are several investigations that are now compared in this scheme of aggregation which have concluded that this enhanced throughput of the network and some more potential savings of energy that can use the data aggregation and the in-network processing for the WSNs. Keeping the efficiency of designing of data aside the task of identification as well as the maintenance of routes in the WSNs will be nontrivial mainly when it also includes the choice of points of aggregation and the routing using such points. Various routing and the dissemination of data along with the protocols of aggregation have been proposed for the WSNs [7][8].

For this work, an energy aware virtual backbone tree has been proposed as the infrastructure of communication for any sensor network and this Energy Aware Virtual Backbone Tree has certain salient features. This considers the issues in energy in various ways: the construction of the energy aware virtual backbone tree will consume very low energy and the nodes that are included in any energy aware virtual backbone tree which have high levels of energy and the data delivery with this tree will consume minimum amount of energy and the energy aware virtual backbone tree will be reconstructed dynamically and the sink nodes will move in this sensor network for keeping the dissipation of energy that is distributed evenly. All this will prolong the sensor network and its lifetime.

III. METHODOLOGY

To increase the life time of the battery in the sensor network, the author has introduced the following method

Energy-aware Virtual Backbone Tree Construction Algorithm

In case of the network model, the following assumptions for that of the sensor network will be considered here. This further comprises of the sink node and a set of the SNs. All such SNs except that of the sink nodes will be static and also power constrained. The power of transmission will be controllable and each of the SNs will have an energy level that is not constrained and will work on the basis of the instructions given by that of the Sensor Management Protocol (SMP). This system administrator will interact with its sensor network by making use of the SMP. All the data and the events that are collected will be reported to that of the sensor network by making use of the SMP. All the data that are collected will be reported to its control center through the sink node and the instructions propagated within the network through the sink node. Each such node will be aware of the location using systems of location finding [9].

Energy Aware Virtual Backbone Tree algorithm

Step1. Dynamic Wireless Nodes

Step2. Aware of Energy Levels of the neighbors

Step3. If energy levels are good to form group, else go to step1.

Step4. Elect Cluster Head (CH), acting as a router in the group

Step5. CH creates a virtual path with other cluster to establish the communication

This energy aware virtual backbone tree algorithm will aim to build one energy efficient tree in the network:

- On behalf of a member in the cluster the CH supports communication with other cluster so that all nodes can maintain their energy levels;
- The life of the wireless network will be increased;
- If CH energy level is trained the election algorithm will elect new CH from the group;
- The CH supports with dynamic nodes to form the groups continuously;
- The wireless performance will be increase because of CH;

The very first as well as the second characteristics will need every relay distance with the tree to be approximate to its characteristic distance ( ) and the branches have to be straight. The next one says that the algorithm of construction of tree has to be energy efficient and the third needs a flexible way for excluding the nodes having low energy outside of the tree with not extra overhead. These are the Combinatorial Optimization (NP) problems that require global information and will make the algorithm simple and practical by adopting a heuristic scheme which will require the sink node (the tree root) and its uplink node information that is coded within the packet of the ECR. For this, the above needs within a single parameter that will be termed as an indicator of fitness ( ). Each such node will estimate this on receiving the ECR as per Equation 1.1.

$$f_i = c_1 f_d + c_2 f_e + c_3 f_\beta \qquad (1.1)$$

In which the , and the are the contributions in the link length that is upstream (d), the level of energy (e ∈ [0, 1]) of its node, and the link direction (β ∈ [-π, π], refer Figure 3.1), that have been weighted by the , and , in Equations 1.2 and 1.3.

$$\begin{aligned} f_d &= 1 - \min(1, abs(d - d_{char}) / d_{char}); \\ f_e &= e; \qquad (1.2) \\ f_\beta &= 1 - abs(\beta) / \pi \end{aligned}$$

$$c_1, c_2, c_3 \geq 0;\ c_1 + c_2 + c_3 = 1 \quad (1.3)$$

Will be bounded inside [0, 1]. In the Equation 3.10, the will guarantee a maximum value at the time the length of the uplink (d) which will be equal to ; will proportional to a level of energy of nodes; the will ensure that the branches in the trees will be straight enough. By means of adjusting the contribution of the weights may be changed to the indicator of fitness ( ) that is within the length of the link (d), the direction of the link (β), and the level of energy (e). Those nodes that have a large has a high probability of becoming the tree node. This node will divide the range of value of it in the M parts as per Equation (1.4):

$$0 = f_i(0) < f_i(1) < f_i(2) < \ldots < f_i(M) = 1 \qquad (1.4)$$

M's value will be decided on the basis of the granularity and control the value being 3 or 4. Every SN will decide if it has to promote it to that of a tree node by means of assessing the in a manner that is distributed at the time of receiving one more new ECR initially and this will estimate the delay in transition ( ) in relation to the as per Equation 1.5:

$$t_d = ((M-k) + random()) * \delta,\ for\ f_i \in [f_i(k), f_i(k+1)] \quad (1.5)$$

In which δ denotes the pre-assigned delay of 5 ms; the random () being a function distributed from 0 to 1 and the node will keep following the channel and wait for it to expire in case the node has not been received the other copy of the ECR at the time of expiry of transition. Else this will drop the ECR and will be excluded from its tree. If the ECR is propagated in the network then energy aware virtual backbone tree.

For this, the mechanism of node-coloring is used for illustrating energy aware virtual backbone tree construction:

- White: This is the node which has not got an ECR packet.
- Black: This tree node belongs to that of an energy aware virtual backbone tree.
- Grey: This is the node discovered and has scheduled events of transitions.
- Blue: This is the node discovered and does not want to be a tree node.

In the beginning all nodes will be white and in the end it gets colored as discussed:

- A sink node will set itself in black and will broadcast the ECR to the neighbors.
- Every white node, getting an ECR will change into a grey node and will estimate delay in transition by Equation 1.5 and schedules it to be triggered at the time of delay expiry.
- If a grey node gets an ECR it turns into blue and chooses a black node to be the upstream node and the transition event scheduled will be cancelled.
- If an event of transition takes place the grey node will be promoted to a black node (or a tree node) and will broadcast this to the ECR.
- If a blue node gets an ECR, it will re-select a black node as an upstream

IV. RESULT AND DISCUSSION

All the SNs are deployed randomly and simulated over 22 clusters where each having its own head that cover every node deployed in the area**.** The parameters utilized for simulation are provided in Table 1.

NS2 is a very large and powerful software which consists of a wide variety of possibilities and it enables the opportunity to simulate entire heterogeneous networks with various protocols.

TABLE. 1 SIMULATION PARAMETERS FOR WSN WITH MOBILE SINK

Parameters	**Value**
Network Area	1000 m × 1000 m
Number of sensor nodes	100 - 1500
Radio range	60 m
Transmitting power of	24.750 mW
Receiving and idle listening	13.500 mW, 13.500
Sleeping power	0..015 mW
Transmission rate/type	1000 bps/CBR
Transmitting radius	25 m
Number of mobile sinks	3
Mobility model	Random way
Speed of mobile sinks	10mbps

In this section, the CDS-based virtual backbone, energy aware tree-based virtual backbone network, energy aware tree-based virtual backbone network with mobile sink, energy aware secure tree-based virtual backbone network and energy aware secure tree-based virtual backbone network with mobile sink methods are used. The Tables 2, 3 and Figures 2 and 3 show the average energy consumption ratio in network after 100 rounds, average packet control overhead, Packet Delivery Ratio (PDR) and end to end delay.

TABLE. 2 AVERAGE ENERGY CONSUMPTION IN JOULES (J) FOR ENERGY AWARE SECURE TREE BASED VIRTUAL BACKBONE NETWORK WITH MOBILE SINK

Number of Nodes	CDS based Virtual Backbone	Energy Aware Tree Based Virtual Backbone Network	Energy Aware Tree Based Virtual Backbone Network with mobile sink
100	0.24	0.22	0.21
300	0.26	0.25	0.23
500	0.27	0.26	0.24
700	0.30	0.28	0.26
900	0.34	0.32	0.30
1100	0.37	0.35	0.33
1300	0.40	0.37	0.35
1500	0.42	0.40	0.37

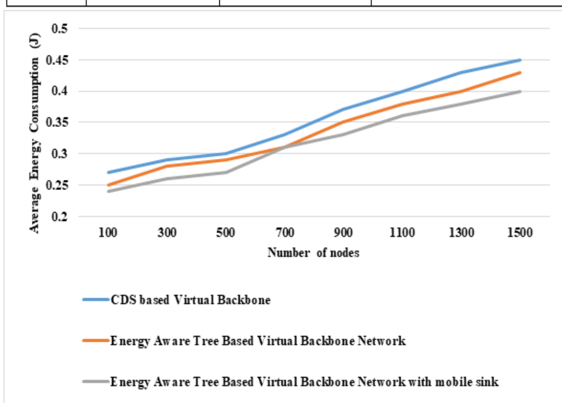

Fig. 2. Average energy consumption in Joules (J) energy aware secure tree based virtual backbone network with mobile sink

From the Figure 2, it can be observed that the energy aware secure tree based virtual backbone network with mobile sink has lower average energy consumption by 25%, 22.22%, 20.89% and 23.37% for CDS based virtual backbone, by 17.39%, 18.86%, 15.38% and 16.21% for energy aware tree based virtual backbone network, by 13.33%, 11.76%, 9.52% and 11.11% for energy aware tree-based virtual backbone network with mobile sink when compared with 100, 500, 900 and 1300 number of nodes, respectively.

TABLE. 3 AVERAGE CONTROL PACKET OVERHEAD FOR ENERGY AWARE SECURE TREE BASED VIRTUAL BACKBONE NETWORK WITH MOBILE SINK

Number of Nodes	CDS based Virtual Backbone	Energy Aware Tree Based Virtual Backbone Network	Energy Aware Tree Based Virtual Backbone Network with mobile sink
100	0.11	0.10	0.09
300	0.12	0.11	0.10
500	0.15	0.14	0.13
700	0.18	0.17	0.16
900	0.20	0.19	0.18
1100	0.22	0.21	0.20
1300	0.24	0.22	0.21
1500	0.26	0.25	0.24

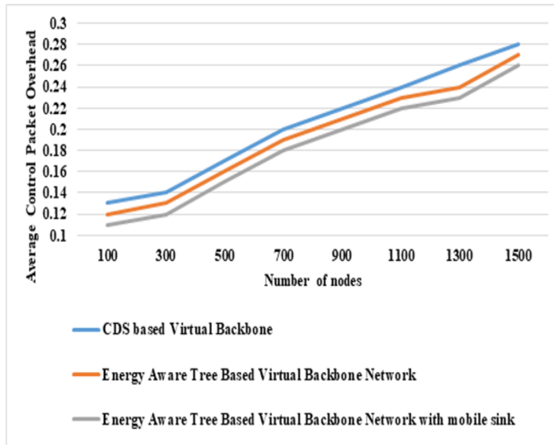

Fig. 3. Average control packet overhead for energy aware secure tree based virtual backbone network with mobile sink

From the Figure 3, it can be observed that the energy aware secure tree-based virtual backbone network with mobile sink has lower average control packet overhead by 16.66%, 26.66%, 20% and 21.27% for CDS based virtual backbone, by 8.69%, 20.68%, 15.38% and 13.33% for energy aware tree-based virtual backbone network, by same value, 14.28%, 10.52% and 9.09% for energy aware tree based virtual backbone network with mobile sink when compared with 100, 500, 900 and 1300 number of nodes, respectively.

The simulation results are compared with other types of back bone models and it is outperformed significantly with existing models.

V. CONCLUSION

A good key management strategy speaks about secure transmission of data. Long distance data transmission by SNs is not energy efficient, since it is energy consumption. Deployment of static and dynamic sink in the network helps to prevent SNs and CH form energy drain in turn it increases sensor networks' lifetimes. Also, a proposed fault tolerant Feed Forward back propagation network algorithm emphasises the lifetime maximisation. This virtual backbone tree is flexible and network is maintained for longer, hence, N – N lifetime is achieved through virtually connected sink. Multi-path transmission is enabled to improve the performance of the network and fast data transmission. Hash function and Ex-OR operation in random partial keys provides us better result to ensure authenticity of a node.

Variable code identity prevents attackers from acquiring the identity of the SN hence compromising of SN is not possible that leads to efficient security. Results proved that the proposed method gives better performance and achieved the major challenges in WSNs

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