A FAULT TOLERANT APPROACH TO ENHANCES WSN LIFETIME IN STAR TOPOLOGY

Dr. S. Murugan[1],M.Anitha Jayaseeli [2]

[1]Dept of Information Technology,Sathyabama University Chennai, India.

[2]Department HOD Dept of Information Technology, Sathyabama University Chennai, India.

Abstract - *In a Wireless Network, there may be a problem of broadcast delay while transmitting the data from one node to another node. Therefore there are chances that there may be a loss of packets. The proposed fault-tolerant methodology enables a system to continue the broadcasting without caring about packet loss. By using minimized delay in broadcast for transmission, data loss can be minimized. If the delay occurs in sink node there must be a possible to loss of both node and packets. To avoid this, Gradient Diffusion algorithm (GD) is applied to increase the lifetime of the node. One more issue that arises while reducing the delay during the transmission is high interference and more concurrent transmissions at expense of data rate. To address above problem, Standard Deviation of Average Remaining Broadcast Time is computed for determining the priority of these parameters. The result of proposed algorithm is to increase the lifetime of the node by reusing it and replace it. From this method the active node increased up to 8 to 9 times, the data loss reduced up to 98 % and the energy consumption is 32 % approximately*

Key Words: **Minimum broadcast delay, Multi-hop Routing, FNR algorithm, wireless STAR networks.**

I. INTRODUCTION

Usually, in Wireless Sensor Network every node has a limitation in computational power which is used to process and transfer the active data to the base station or data collection center. Based on the sensor nodes only the WSN increase the Sensor area and the Transmission area. but each sensor nodes has a low energy that must be replenished. As soon as it became exhausted. It will lead to the leaks and the node became failed. Due to the failed nodes will not relay data to the other nodes during transmission. Therefore the problem of overload to other sensor nodes with increasing transmission processing.

In proposes of this paper is, a Fault tolerant approach to increase the lifetime of a wireless sensor network (WSN) when some of the sensor nodes died, either because they no longer have battery energy or they have reached their operational threshold. A network of Wireless Sensor Node is created with limited energy. Power and transmission scheduling are assigned to reduce packet-based broadcast from a root node to others. Although it minimizes the broadcast delay the lifetime of a node is not determined here. Since we include a gradient algorithm to increase the node lifetime and the fault tolerant is maintained. Using the approach can result in reusing and replacing of sensor nodes Thus, the approach increases the WSN lifetime and also there is no replacement cost for sensor nodes.

II. RELATED WORK

Broadcast scheduling is a fundamental problem in multi-hop wireless networks. The objective of a broadcast schedule is to deliver a message from a given source to all the other nodes in the network in a minimum amount of time with the constraint that parallel transmissions cannot interfere with each other. [1]In this paper, we address the problem of joint power control and scheduling for minimizing broadcast delay in wireless mesh networks. Given a set of mesh routers and a routing tree, we aim to assign power for relay nodes and compute an optimal transmission schedule such that the total delay for a packet broadcast from the root to all the routers is minimized. We consider rate adaptation in our scheme. This is a difficult issue. High power enables high data rate but causes high interference, whereas low power allows more concurrent transmissions at the expense of data rate. With regard to multicast scheduling and power control, several proposals have appeared in the literature.

The authors in [3], [4] addressed the problem of cooperative multicast scheduling for power allocation in multi-channel condition to enhance network performance. Since some nodes can relay messages to the destinations, the main idea of those works is to combine multiple replicas of the same message from different transmitters at the receivers to enhance the quality of signals. However, both of the two works solve the problem from physical layer's perspective and they only consider the cooperation in two-hop transmission. Topology control is defined as controlling the neighbor set of nodes in a WSN by adjusting transmission range and/or selecting specific nodes to forward the messages [5].

Topology control approaches can be divided into two main categories, namely, homogeneous and non homogeneous [6]. In homogeneous approaches transmission range of all sensors are the same whereas in non homogeneous approaches nodes can have different transmission ranges. There are many topology control methods proposed in literature and they can be classified according to the techniques they use. Many topology control methods are built on the transmit power adjustment technique which depends on the ability of sensors to control their transmit power.

III. PROPOSED WORK

A. Diffusion Algorithm

A sequence of routing algorithm [10], [14] for wireless sensor networks has been introduced in recent years. C. Intanagonwiwat et al. proposed the Direct Diffusion (DD) algorithm [9] in 2003. The aim of the DD algorithm is to decrease the data relay transmission counts for power management. The DD algorithm is a query-driven transmission protocol. The arranged data is transmitted only if it matches the query from the sink node. In the DD algorithm, the sink specifies the queries in the form of attribute –value pairs to the other sensor nodes by forwarding the query packets to the entire network. Simultaneously, the sensor nodes send the data back to the sink node only when it fits the queries.

B. Grade Diffusion Algorithm

H. C. Shih et al. proposed the Grade Diffusion (GD) algorithm [7] in 2012 to enhance the ladder diffusion algorithm using ant colony optimization (LD-ACO) for wireless sensor networks [6]. The GD algorithm not only creates the routing for each sensor node but also notices a pair of nearby nodes to decrease the transmission loading .Each sensor nodes can select a sensor node from the pair of nearby nodes when its grade table lacks a node able to perform the relay. The GD algorithm can also store some information based on the data relay. Then a sensor node can select a node with a lighter loading or more available energy than the other nodes to perform the additional relay operation. That is, the GD algorithm updates routing path in real time and the event data is thus send to sink node quickly and correctly.

The WSN may fail due to different type of causes, including the following: the routing path may experience a break; the WSN sensing area may experience a leak; the batteries of some sensor nodes may be reduced depending on more relay nodes; or other nodes wear out after the WSN has been in use a long interval of time.

The power conception of the sensor node in WSN can never be avoided. This paper however illustrates an algorithm to identify for and replace lesser sensor nodes and to reuse the most routing paths. Conventional identification techniques are always incapable of optimizing nonlinear operation with several variables. One scheme,

C .Fault Node Recovery Algorithm

This paper illustrates a fault node recovery (FNR) algorithm for WSNs depends on the grade diffusion algorithm along with the genetic algorithm. The FNR algorithm discovers the grade value, routing table, nearby nodes, and payload value for each sensor node using the grade diffusion algorithm. In the FNR algorithm, the sequence of non operating sensor nodes is determined the wireless sensor network operation, and the parameter Bth is determined according to (1).The FNR algorithm identifies the grade value, routing table, a pair of nearby nodes, and payload value for each sensor node, using the grade diffusion algorithm. The sensor node transfers the event data to the sink node which depends on the GD algorithm when event occurs. Then, Bth is greater than zero, the algorithm will be called and released non operating sensor nodes by functional nodes determining by the genetic algorithm. Then the wireless sensor network can continue to function as long as the operators are ready to replace senor.

The parameter is encoded in binary string and serves as the, chromosomes of the GA. the elements (or bits), the genes in the binary strings are adjusted to reduce or increase the fitness value. The fitness operation generates its fitness value, which is composed of many variables to be optimized by the GA. At each iteration of the GA, a already defined values along with the chromosomes. There are 5 steps in the genetic algorithm: Initialization, Evaluation, Selection, Crossover and algorithm.

IV. SIMULATION

A simulation of the fault node recovery algorithm as described in Section 3 was performed to verify the method. The experiment was designed based on 3-D space, using 100×100 × 100 units, and the scale of the coordinate axis for each dimension was set at 0 to 100. The radio ranges (transmission range) of the nodes were set to 15 units. In each of these simulations, the sensor nodes were distributed uniformly over the space. There are three sensor nodes randomly distributed in 10 × 10 × 10 space, and the Euclidean distance is at least 2 units between any two sensor nodes. Therefore, there are 3000 sensor nodes in the 3-D wireless sensor network simulator, and the center node is the sink node. The data packages were exchanged between random source/destination pairs with 90 000 event data packages. In our simulations,

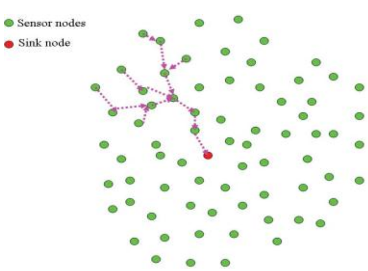

Fig -1: Wireless sensor node routing.

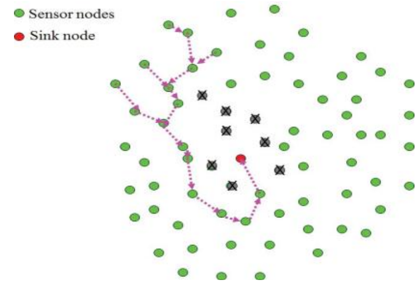

Fig -2: Wireless sensor node routing path when some nodes are not functioning.

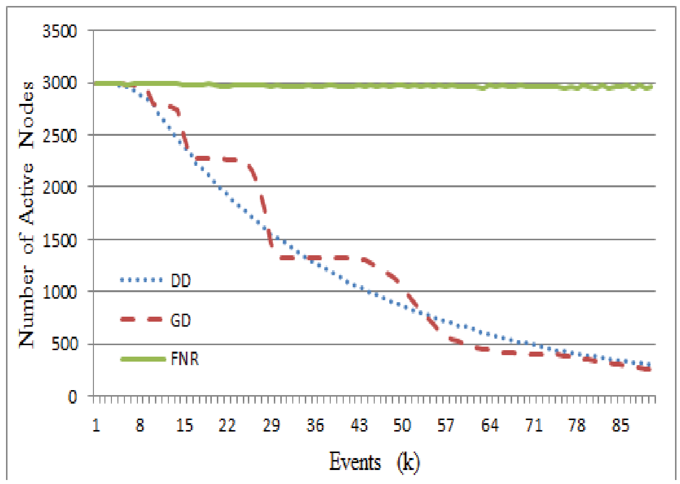

Chart -1: Number of active nodes.

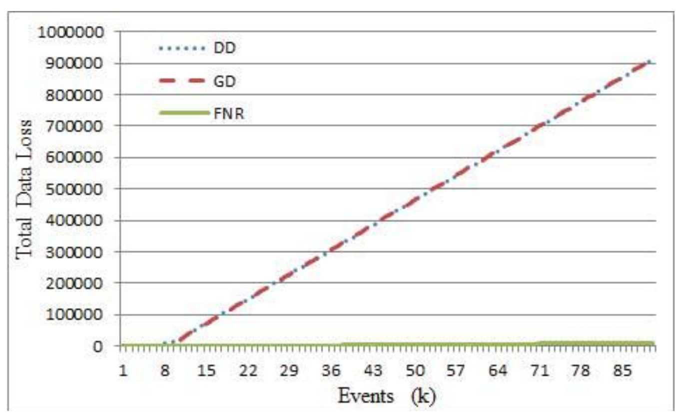

Chart -2: Total data loss.

the energy of each sensor node was set to 3600 Ws that is the actual available energy. Each sensor consumed 1.6 Ws when it conducts a completed data transformation ($Rx + Tx$).In the GA algorithm, the population size was 20; the crossover rate was 50%; and the mutation rate was 2%.The FNR, DD, and GD algorithms were implemented. The active sensor nodes and total data loss after 90 000 events are shown in Figs. 3 and 4.

The active nodes mean that the sensor node has enough energy to transfer data to other nodes, but some sensor nodes can be deleted from the active nodes list if their routing tables do not have a sensor node that can be used as a relay node, or if they are not in the routing table of any other sensor nodes. This new algorithm enhances the number of active nodes by8.7 and 10.8 times, respectively. The FNR algorithm has the most active sensor nodes compared with the DD and GD algorithms because the algorithm can replace the sensor nodes after the number of nonfunctioning nodes exceeds the threshold, by using the GA algorithm. Fig. 4 compares the total data loss using the FNR algorithm to the total data loss using the DD and GD algorithms. In this simulation, event data was destroyed and recorded into the loss count if the data had already been relayed over 20 times.

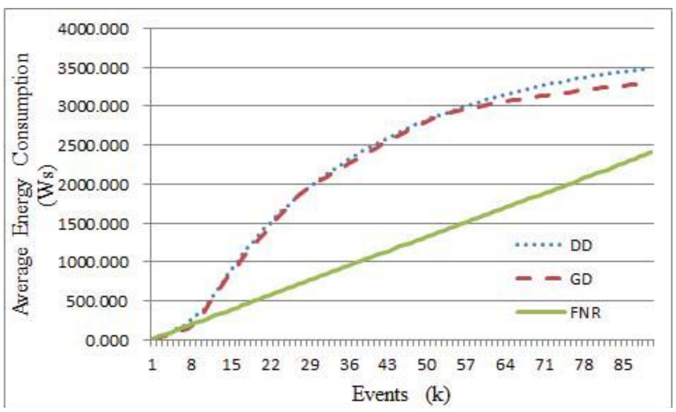

Chart -3: Average energy consumption

and transfer them to the sink node if the WSN lifetime is increased. In Fig. 4, the FNR algorithm exhibits smaller data losses because the algorithm can replace fewer sensor nodes and reuse more routing paths if the number of sensor nodes that are nonfunctioning exceeds the threshold. After the simulation, the FNR algorithm had only suffered 11 025 data losses, but the DD and GD algorithm had suffered 912 462 and 913 449data losses.

This new algorithm can reduce data loss by 98.8%compared to the traditional algorithms. Fig. 5 compares the average energy consumption of a WSN managed using the FNR algorithm to the average energy consumption using the DD and GD algorithms. The DD and GD algorithms allow the WSN to consume more energy after8 000 events because the inside nodes are energy-depleted, but the outside nodes continue to attempt to transfer event data to the sink node through the inside nodes until they are also energy-depleted. After 90 000 events, the DD and GD algorithm-managed WSNs had consumed 3495.17 Ws and3298.29 Ws, respectively.

The proposed algorithm increases the WSN lifetime by replacing some of the sensor nodes that are not functioning. In addition to enhancing the active nodes and reducing the data losses, the FNR algorithm reduces the relayed energy consumption by reducing the number of data relayed, as there placed sensor nodes are usually used the most. After 90 000events, using the proposed algorithm, the WSN had consumed only 2407.68 Ws, and, compared to using the DD and GD algorithms, exhibited a reduction in energy consumption of31.1% and 27%, respectively. After that, we experiment different node densities in our simulation environment to compare the average energy consumption. The simulate result is shown in Table I. We can find that the FNR algorithm has the least average energy consumption in all case, and it can save 31.73% energy at most in Table I.

Hence, the FNR algorithm has the best energy saving performance no matter under any node densities. The average number of messages that reach the sink node when each algorithm manages the network is compared in Fig. 6. Using the traditional DD and GD algorithms, the sink node can receive no messages after 8000 events because all of the inside nodes are energy-depleted, and the WSN lifetime is ended. This proposed algorithm replaces energy depleted sensor nodes to increase the WSN lifetime. Therefore, the average number of messages received using

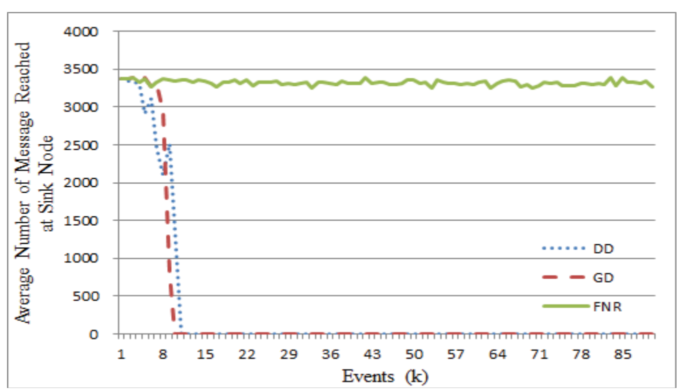

Chart -4: Average number of messages reaching the sink node.

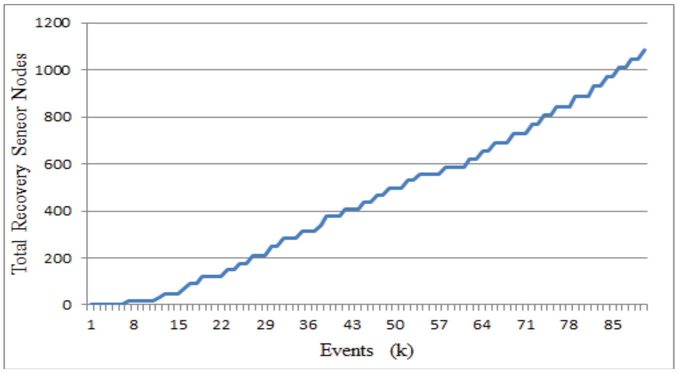

Chart -5: Total number of sensor nodes recovered.

Using this algorithm is higher than when using the other algorithms. By using this algorithm, the sensor nodes are not only replaced, but the replacement cost is reduced, and more routing paths are reused. The total number of sensor nodes recovered is shown in Fig. 7.From Fig. 7, 1085 sensor nodes were recovered, and the FNR algorithm continues to run for 34 iterations after 90 000events. In the simulation, the algorithm replaced, on average, approximately 32 sensor nodes for each calculation, extending the lifetime of the WSN.

Using the FNR algorithm, if the grade 1 sensor nodes consume their energy rapidly because they try to transfer event data to the sink node using neighbor nodes if the grade 1 sensor nodes are energy-depleted or their routing table is empty. The FNR algorithm has ample energy for each grade sensor node because the algorithm can replace the sensor nodes, but it reuses more routing paths compared to using the traditional algorithm. The number of replaced sensor nodes and the total number of messages.

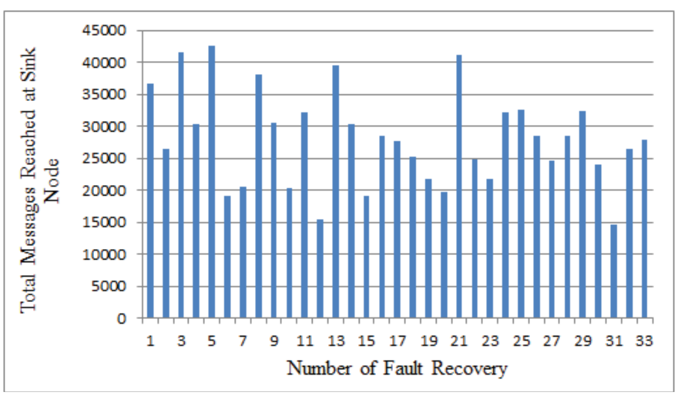

Chart -6: Total messages reaching the sink node for each replaced node.

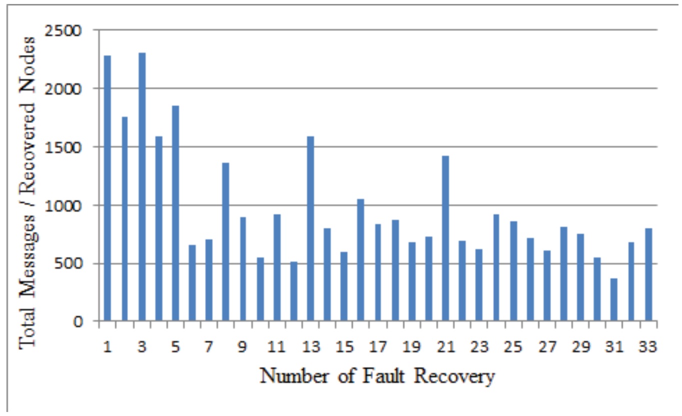

Chart -7: Rate of total messages to recovery nodes.

V. CONCLUSION

In this paper, we have studied the issue of scheduling for minimizing broadcast delay from the gateway node to all the star routers in WSNs and Fault Node recovery when some of the nodes shut down. We introduce standard deviation of average remaining broadcast time to determine the priority of data-rate-first approach and concurrency-first approach. Based on this concept, we propose a balanced method to solve the problem. A fault node recovery algorithm for WSN based on the grade diffusion algorithm combined with a genetic algorithm. The FNR algorithm requires replacing fewer sensor nodes and reuses the most routing paths, increasing the WSN lifetime and reducing the replacement cost.

Extensive simulations have demonstrated that our proposed method can reduce the broadcast delay significantly compared with the methods using fixed transmission power. In addition, increases the number of active nodes up to 8.7 times. The algorithm reduces the rate of data loss by approximately 98.8% and reduces the rate of energy consumption by approximately 31.1% Therefore, the FNR algorithm not only replaces sensor nodes, but also reduces the replacement cost and reuses the most routing paths to increase the WSN lifetime.

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