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Improving Quality of Service of WSN by Data Aggregation

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Abstract: - *Data aggregation is a very crucial technique in WSNs. Data aggregation helps in reducing the energy consumption by eliminating redundancy. Currently, most of the existing works focus on constructing DATs according to different user requirements under the Deterministic Network Model (DNM).due to the existence of many probabilistic lossy links in WSNs so the current work which spend lots of efforts on aggregation, so we mainly focus on DAT construction problem. The proposed, we focus on constructing a Load-Balanced Data Aggregation Tree (LBDAT) under the PNM, we define two new metrics potential load, and actual load. First we identify MIS(Independent nodes with respect to the root node) and connected MIS (Connecting Nodes). Finally, we calculate Load-Balanced Parent Node Assignment (LBPNA) structure by identifying links to be used across neighbouring nodes. The tree structure identified here will be utilized for communication across the leaf and root node of the network.*
Keywords: - *Data Aggregation Tree, Probabilistic Network ,Potential load, Independent nodes)*

I. Introduction

In WSN tiny sensor nodes are densely deployed either inside the phenomenon or very close to it. Nodes senses the data, processes it and communicates with components[1]. Nodes deployment is possible in inaccessible area or in disaster relief operations [3]. This means sensor network protocols and algorithms must posses self organising capability, cooperative effects of sensor nodes and inboard processor (Inside nodes). As nodes are densely deployed, neighbouring nodes may be very close to each other and multihop communication occurs which consumes less power than traditional single hop communication [1] . Also it is possible to maintain low power level. Multihop communication effectively overcomes some of the signal propagation effects like two way propagation or doppler shift in long distance wireless communication[5].

Data aggregation is process of collection of data from many sensor nodes in more compact form before forwarding it to the destination[2]. Data aggregation can be done by two ways data centric routing and attribute based addressing. Data centric approach is used for routing of collected or aggregate data [7]. This data centric routing is again divided into two parts, one is sink broadcast routing and sensor node broadcasting.

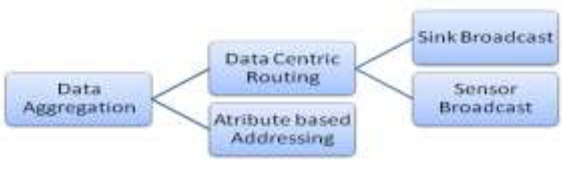

Fig. 1. Hierarchy of Data aggregation

PROBABILISTIC WIRELESS SENSOR NETWORK

A. Simulation Tool

To study and observe the result of load balancing and data aggregation in wireless sensor network, we need a simulator which is able to simulate the networking projects. For this purpose we are going to use NS-2 network simulator. NS-2 is most widely used general purpose network simulator. NS-2 is able to simulate different types of wired and wireless simulations for example IP based network Protocol and 802.11 standard based wireless network[4].

NS-2 is written in C++ on TcL (Object oriented version of TcL)therefore it is known as discrete event and object oriented simulator. In NS-2 sensorsim and Mannasim are the well known and frequently used environments[6].

B. Network model

For data aggregation and load balancing we are going to use PNM (Probabilistic Network Model). for this model we initially set some assumptions.

We assume our network to be static in nature, connected WSN have n no of nodes in a set. For example Ws= w1; w2;.......wn and one sink node w0.
Transmission range of all nodes is same.
Each link which connects pair of nodes let say vi : vj are associated with the transmission success ratio Lij, to obtain this ratio generally we send hello messages periodically or it can be predicted by using Link Quality Index (LQI).
Value of transmission success ratio Lij are fixed. This is because many empirical studies says that LQI is mostly stable in a static environment .
Furthermore, no node failure is considered since it is equivalent to a link failure case. No duty cycle is considered neither. We do not consider packet collisions or transmission congestion, which are left to the MAC layer.
Next we assume that the n nodes monitor the environment in the deployed area and periodically report the collected data to the sink node v0 along the LBDAT .
Every node produces a data package of B bits during each report interval. Moreover, an intermediate node can aggregate multiple incoming B-bit packets, together with its own package into a single outgoing B-bit package.
Under the Probabilistic Network Model (PNM), we model a WSN as an undirected graph G(V;E;P(E)), where V = VsUv0 is the set of n + 1 nodes, denoted by vi , where $0 \le i \le n$.. i is called the node ID of vi in the paper. E is the set of lossy links. ∀vi ; vj ∈ V , there exists a link (vi ; vj) in G if and only if: 1) (vi and vj are in each others transmission range, and 2)Lij > 0. For each link (vi ; vj) ∈ E, Lij indicates the probability that node vi can successfully directly deliver a packet to node vj . We assume the links are undirected (bidirectional), which means two linked nodes are able to transmit and receive information from each other with the same Lij value.

II. Algoritham

Here are some definitions related with the terms in algorithm
n: No.of nodes
d :Node degree
Lij :Transmission success ratio
R:Packets received by node j
T: Packets transmitted by node i
P(E): Probability of packet transmission
w :Weight on the node
Steps of Algoritham
The following algorithm is used to construct LBDAT
V = VsU v0 Set of nodes on undirected graph G(V, E, P(E)) |Vs| = n |V | = n + 1
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- Step 1: calculate one hop neighbourhood for all the nodes i.e.N1(vi), $0 \le i \le n$. list neighbouring nodes
- Step 2 : Calculate node degree of each node i.e. di = |N1(vi)| for ∀vi ∈ V ; $0 \le i \le n$ no of neighbouring nodes
- Step 3 : Calculate average degree of the graph G(V, E, P(E)) i.e. dAV G = Pdi n+1
- Step 4: calculate transmission success ratio Lij associated with each link connecting a pair of nodes vi and vj , where ∀vj ∈ N1(vi). i.e. for(i = 0; i ≤ n;i + +) { for(j = 0; i ≤ |N1(vi)|; j + +) { L[i][j] = R T } }
- Step 5: calculate potential load(ρi) at each node
- Step 5: calculate potential load(ρi) at each node
- Step 6: Calculate average potential load of the graph G(V, E, P(E)) i.e. ρAV G = Pρi n+1
- Step 7 : obtain the product xi = |di − dAV G| ∗ |ρi − ρAV G| ∀vi ∈ Vs ;1 ≤ i ≤ n Note : We won't calculate the Product for v0i.e. for the sink node as v0 is added to the MIS by default.
- Step 8 : sort all sensor nodes by the xi values in increasing order and the sorted node Ids are stored in array denoted by A[n] .
- Step 9 : Let wi be the decision variable such that , wi = 1 Node is a dominator (independent) wi = 0 Node is not a dominator All the dominators together form a Maximal Independent set (MIS). Initially, set w0 = 1 i.e. sink node is consider as member of MIS by default Set wi = 0| ∀vi ∈ Vs; 1 ≤ i ≤ n
- Step 10 : k = 0 While k < n do

```
 { i = A[k]; set flag = 1 for each (vj ∈ N1(vi)){ if (wj ! = 0)
{ setFlag = 0;
Break;
          } }
```

if(flag == 1) then seti = 1 ; k = k + 1 }
Step 10 execute N times where N is no of nodes.
The proposed algorithm will first find out node degree and then it will calculate transmission success ratio .The potential load is also calculated in this algorithm .The nodes are arranged in ascending order of the load .Then it will decide the weight on the load which will decide the node is Independent or dependent. Then it will start to connect the edges .After that communication will start within that nodes

III. Simulation Results

With the help of above algorithm we are able to calculated the Transmission success ratio Lij. Once we have the value of Lij we can find out the potential load. Table given below shows potential load of each individual load. Then we have to calculate the average node degree and average potential load then we will get the value of x, which we have to arrange in increasing order. Once we know the values of x we have to assign weight to individual node.

node id node	node degree	potential load	node id node	node degree	potential load
0	4	0.5960	17	3	0.0215
1	2	0.0194	18	6	0.0434
2	4	0.0593	19	3	0.0271
3	2	0.0196	20	4	0.0295
4	2	0.0118	21	4	0.0264
5	3	0.0197	22	3	0.0264
6	4	0.2792	23	5	0.0527
7	6	0.0467	24	2	0.0527
8	4	0.0418	25	3	0.0297
9	5	0.1058	26	6	0.0461
10	3	0.0206	27	3	0.0222
11	6	0.0318	28	5	0.0557
12	3	0.0207	29	3	0.0232
13	3	0.3212	30	4	0.0285
14	3	0.0340	31	3	0.0264
15	4	0.0468			
16	3	0.0350			

Table.1. Node id and Potential load

The NS-2 simulator is used to simulate the code. For this simulation we have taken simulation area equal to 800*800. For the communication between nodes AODV routing protocol is used. In this simulation we have simulated the network structure of 32 nodes out of which one node is root node. Bit rate is 8 and Receiving rate is 1024.

The energy consumption model is that every node has the same initial 1000 units of energy. Receiving a packet consumes 1 unit of energy, while transmitting a packet consumes 2 units of energy. In the simulation, we consider the following tunable parameters: the node transmission range and the total number of nodes deployed in the square area.

The nodes with their assigned weight is shown in table 2.the weight is assigned by using Values of x from the previous step. If w=0 it shows the node is dependent and if w=1 then the node is independent. Node 0 is by default independent node so it is having the weight =1.It is also referred as root node. So all data sensed by the leaf node will be sent to the root node that is node 0. Node 0 starts transmitting hello packets to find out neighboring independent node.

Node ID	weight	Node ID	weight
0	1	16	0
1	0	17	0
2	0	18	0
3	1	19	0
4	0	20	1
5	0	21	0
6	0	22	0
7	0	23	1
8	1	24	0
9	0	25	0
10	0	26	0
11	1	27	0
12	0	28	1
13	0	29	1

14	1	30	0
15	1	31	0

Table.2. Weight assignment for nodes

Level 0	Level 1	Level 2
0	23	3
	28	29
	11	20
	8	
	14	
	15	

Table.3. leveling of independent nodes

CS 0	CS 1
2	7
9	24
6	18
13	

Table 4: leveling of dependent nodes

1:8	13:0	30:20
2:0	16:14	31:11
4:28	17:20	
5:8	18:15	
6:0	19:14	
7:28	22:29	
9:0	24:23	
10:11	25:3	
12:20	26:8	
21:11	27:29	

Table 5: Edges for leaf node assignment

Table 3 contains the leveling of independent node.Root node sends the HELLO packets to the independent node to find out level 1 node.Likewise The level 1 nodes does the same action to find out level 2 nodes.All are listed in Table 3.Table 4 contains the dependent nodes i.e the connecting set of nodes.

For the proper communication between nodes we have to nd out the connecting edges i.e which dependent node will connect to independent node.It is given in table 5

The graphical representation is given in the fig.2 which compares the average Energy consumption by the nodes.The energy consumption with load balancing is less than without load balancing. Thus, the lifetime of the whole network is extended, which means the remaining energy of the network is less than DAT. In summary, Fig.2 indicates that

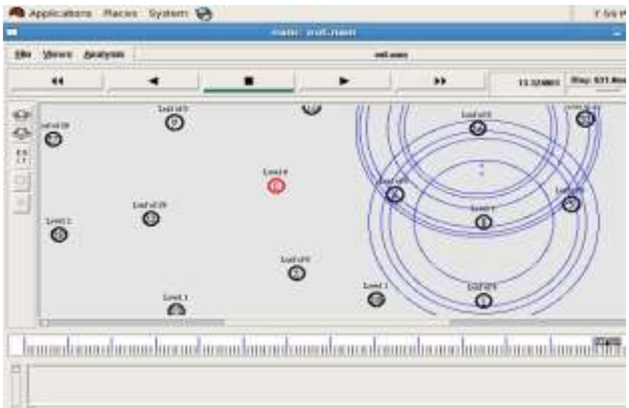

Fig.2. Communication between the nodes

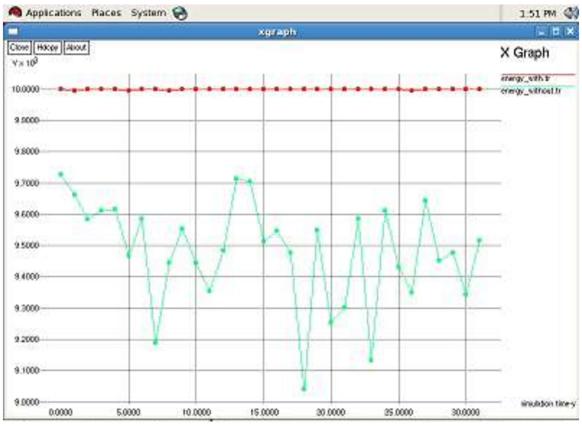

Fig.3. Comparison of average energy with and without load balancing.

constructing an LBDAT can balance the energy consumption on each non-leaf node, and make the lifetime of the whole network prolonged considerably.

IV. Conclusion

In the first phase, we aim to find the optimal MIS such that the minimum potential load of all the independent nodes is maximized. To this end, a near optimal approximation algorithm is proposed. In the second phase, the minimum-sized set of LBMIS connectors are found to make the LBMIS connected. The theoretical lower and upper bounds of the number of non-leaf nodes are analyzed as well. Subsequently, we study the LBDAT construction problem. After an LBPNA is decided, by assigning a direction to each link, we obtain an LBDAT.

The simulation results show that the proposed algorithms can extend network lifetime significantly. The graphical representation of the energy with and without load balancing is also analyzed. Thus, the lifetime of the whole network is extended, which means the remaining energy of the network is less than DAT. Constructing an LBDAT can balance the energy consumption on each non-leaf node, and make the lifetime of the whole network prolonged considerably.

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