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Neighboring Load Balancing Approach in Grid Wireless Sensor Network

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***Abstract**: As Sensor area network is a vast network with thousands of nodes, the workload increases up to a great extent. Wireless sensor networks are increasingly gaining importance in various time critical applications. As a sensor node has fix power to work on, when the load exceeds its threshold value, it starts behaving abnormally and starts packet as well as energy loss while the corner nodes are underutilized. This uneven load distribution results in heavily loaded nodes to discharge faster as compared to others. This causes few over-utilized nodes which fail and result in formation of holes in network, resulting in increase of failed messages in the network. This increased workload leads to increase in packet loss and decrease in network lifetime. Even the rate of message failure as well as node failure due to network congestion also increases. In order to avoid such problems and enhance the network lifetime, we are introducing a new algorithm for the purpose of load balancing i.e. Neighboring Load Balancing. Neighboring Load Balancing is a type of load balancing approach in which load has to be distributed on neighboring nodes instead of central nodes in which an All to All communication mode has been assumed. In this, the load is distributed on all those neighboring nodes which are in coverage area of central node.*

***Keywords:** Load balancing, center node, neighboring nodes, sensor network.*

1. INTRODUCTION

Wireless sensor network (WSN) consists of large number of scattered sensing devices which monitor physical or environmental conditions such as temperature, sound, pressure, motion or pollutants. These sensing devices are responsible for data commu0nication. The sensing nodes communicate with each other using low power wireless data routing protocols [1]. Sensor network is a subclass of ad hoc network and varies with it in terms of number of nodes, deployment strategy, failure rate, power etc [2].

1.1 Sensor Network Communication Architecture

The sensor nodes are geographically distributed as shown in Fig. 1. These scattered sensor nodes has data collecting and routing capability..

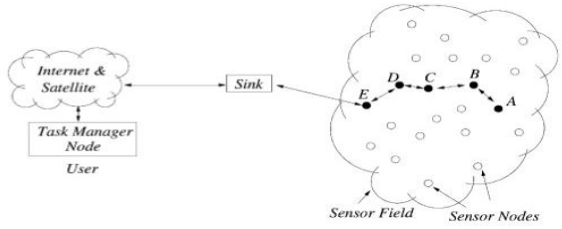

Figure 1: Sensor nodes scattered in a sensor field [2]

Gathered information has to be routed back to the sink node through multi-hop communication architecture. The sink communicates with the task manager node or user through Internet or satellite communication [2].

2. LOAD BALANCING STRATEGIES

The three important parameters needs to be taken into account in order to select best among the different load balancing algorithm:

a) who is responsible for making the load balancing decision
b) what information is used to make the load balancing decision
c) Where the decision has been made.

Let us consider the load balancing strategies in detail.

2.1 Centralized Load Balancing

In centralized load balancing [3], central node is responsible for calculation of amount of load to be transferred as well as load distribution to other sensor nodes. As the central node is responsible for task distribution, the whole network goes

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down if this node fails. However, the policy involves one-to-all as well as all-to-one communication mode.

2.2 Local or Global Load balancing strategy

In local load balancing strategy [3], all the sensing devices are divided into heterogeneous groups provided that each group has same performance profile i.e. same computational power. The decision making node would send polling message to each group head which in turn sends the message to its group members demanding the information about the amount of load each node can handle. Based on this information, the decision making node decides to which node the load has to be distributed. In contrast, global load balancing strategy [3] involves the exchange of performance profile information globally among each and every node. The single point of failure and network latency problems of local load balancing technique has been eliminated by this strategy.

2.3 Static or Dynamic Load Balancing

In static load balancing strategy, the load has been assigned to all the nodes in the beginning and there is no variation in the load in between. This type of strategy does not require constant load monitoring and is not well suited for real time applications.

In dynamic load balancing [4][5], load scheduling is done at run time based on the current status of the participating nodes. It is an adaptive policy as the frequent changes in terms of channel traffic; channel delay etc can be entertained. Dynamic methods generally react better to changes in the system state compared to the static methods and as a result, have better performance.

2.4 Sender-initiated or receiver –initiated load balancing

In sender-initiated policies [5], congested nodes attempt to move the work to lightly-loaded nodes while in receiver-initiated policies [5], lightly-loaded nodes look for heavily-loaded nodes from which work can be received.

3. EXISTING SYSTEM

3.1 Centralized Load Balancing

In this approach as the network traffic pass from some central node network congestion increases which leads to packet loss at that node. If this central node is paralyzed then the whole network gets stuck. Centralized load balancing as shown in fig 3, is used when the nodes requires global information about the state of the system [6]. Various centralized load balancing strategies such as Random LB, Greedy LB, and Horizontal Vertical Routing etc are available but each has its own limitations as explained in section 3.2. Thus, several authors have proposed different methods of load balancing. As Serve to recently proposed in [7], a routing algorithm which reduces the load on the central node in a single source–single destination communication. It divides the network into expansion and compression phases. Sensor nodes belong to deferent diagonals of the grid. During expansion phase, the load per node decreases with the increase in number of nodes on diagonal. During the compression phase, the reverse process is carried out and with the decrease in number of nodes on each diagonal, the load per node increases. In [8], Stefan analyzes the reliability of the system in the case of node failures. The reliability of the system can be increased by providing several paths from source to destination and sending the same packet through this paths. In this it analyze the mechanism through which the trade off between traffic and reliability can be controlled by splitting in K sub packets.

All the approaches defined by various authors are complex as well as deal with central node only. So, there is a great need of a new load balancing strategy which helps to decrease the amount of load on the central node thereby ignoring the central node.

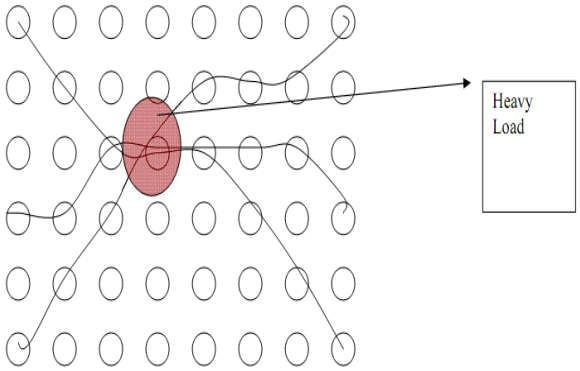

Figure 2: Grid Wireless Sensor network

3.2 Limitations of Centralized Load Balancing

Various limitations of centralized load balancing scheme are:

- The scheme leads to increase in congestion in the whole network.
- It leads to creation of hot spots.
- Number of failed messages increases in the network
- It unnecessarily creates heavily loaded nodes.
- Network lifetime decreases
- Packet Loss increases
- Formation of holes

The existing centralized scheme was implemented using Network Simulator version 2 (NS2) [9]. The packet loss as well as packet received rate was taken as a parameter for computing the overall performance of the network.

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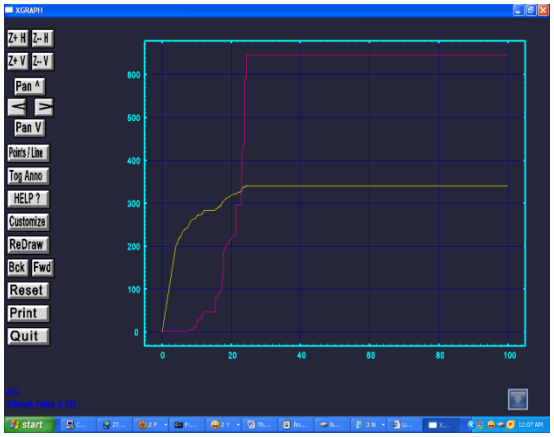

Figure 3: Packet Loss vs. Packet Received (existing)

These rates of packet received as well as packet loss are then plotted on a graph using Xgraph [9]. In case of existing system i.e. centralized load balancing, packet received is more as compared to packet loss as shown in fig 4. However, the amount of packet received can be increased at a greater rate using distributed load balancing. To overcome the bottleneck due to congestion at central node we are proposing an approach to distribute the load on all the neighboring nodes.

4. NEW PROPOSED SCHEME

Wireless sensor networks are increasingly gaining importance in various time critical applications. Generally, greedy approach is followed by the sensing devices for data transmission. As a sensor node has fix power to work on, when the load exceeds its threshold value, it starts behaving abnormally and starts packet as well as energy loss while the corner nodes are underutilized. This uneven load distribution results in heavily loaded nodes to discharge faster as compared to others. This causes few over-utilized nodes which fail and result in formation of holes in network, resulting in increase of failed messages in the network. Hence, a new load balancing strategy which is termed as Neighboring Load Balancing approach has been proposed so that the underutilized nodes can be better utilized and the workload on over-utilized nodes can be decreased up to some extent.
In this, the load is distributed on all those neighboring nodes which are in coverage area of central node.

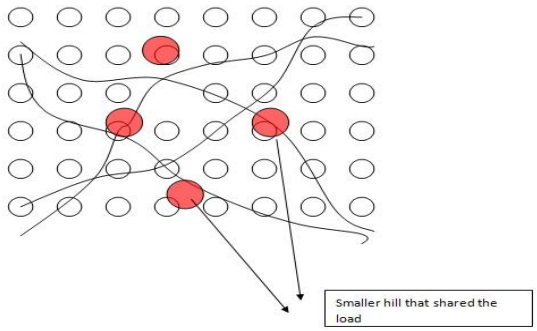

Figure 4: Neighboring Load Balancing approach

4.1 Basic Idea

The main objective behind this research is to develop a center-compromised routing algorithm for congested grid network as well as to share the load among the under-utilized nodes so that inbound internet protocol (IP) traffic can be distributed across multiple sensing nodes.

4.2 Objectives

The main objectives behind this research are as follows:

- To increase energy efficiency of whole network.
- To increase the network lifetime.
- To Decrease the congestion in whole network.
- To minimize the formation of holes.
- To minimize the packet loss at central node.
- To increase the packet received rate.
- To Maintain Network Connectivity.

4.3 Proposed Algorithm

A grid network has been considered in the algorithm where each sensor node can transfer data to any of the other sensor node. The proposed algorithm has been divided into two parts namely Node Detection and Load Distribution. The algorithm makes use of two data structures namely FIFO queue and list. The queue has been used for the purpose of detection of under-utilized nodes while the list has been used for the purpose of storing the nodes present in shortest path to designated node.

Various assumptions for Neighboring Load Balancing approach are as follows:

- Initially, the workload has been assigned to all the sensing nodes present in the network.
- The amount of data packets to be distributed should be known in advance.
- All the threshold values should be set first.

```
/* Node Detection Algorithm*/
    /*S is the Source Node and D represents the
                Destination Node */
  Step 1  Find the Shortest Path between S to D
          using
            Dijkstra Algorithm.
  Step 2  Maintain a List1 L1 ( I0,I1.....In) of all the
           routing nodes present on the shortest path.
  Step 3  for each (Node In in L1)
           {
              If (Load(In)>Threshold)
              Put In in List2 L2 (F1,F2.....Fm)
           }

  Step 4    X= MAX (F1,F2.....Fm)
  Step 5   Set X as Central Node
  Step 6   Find Compromising Nodes of X and put
            them in queue called CNQ (C0 to Cq)
```

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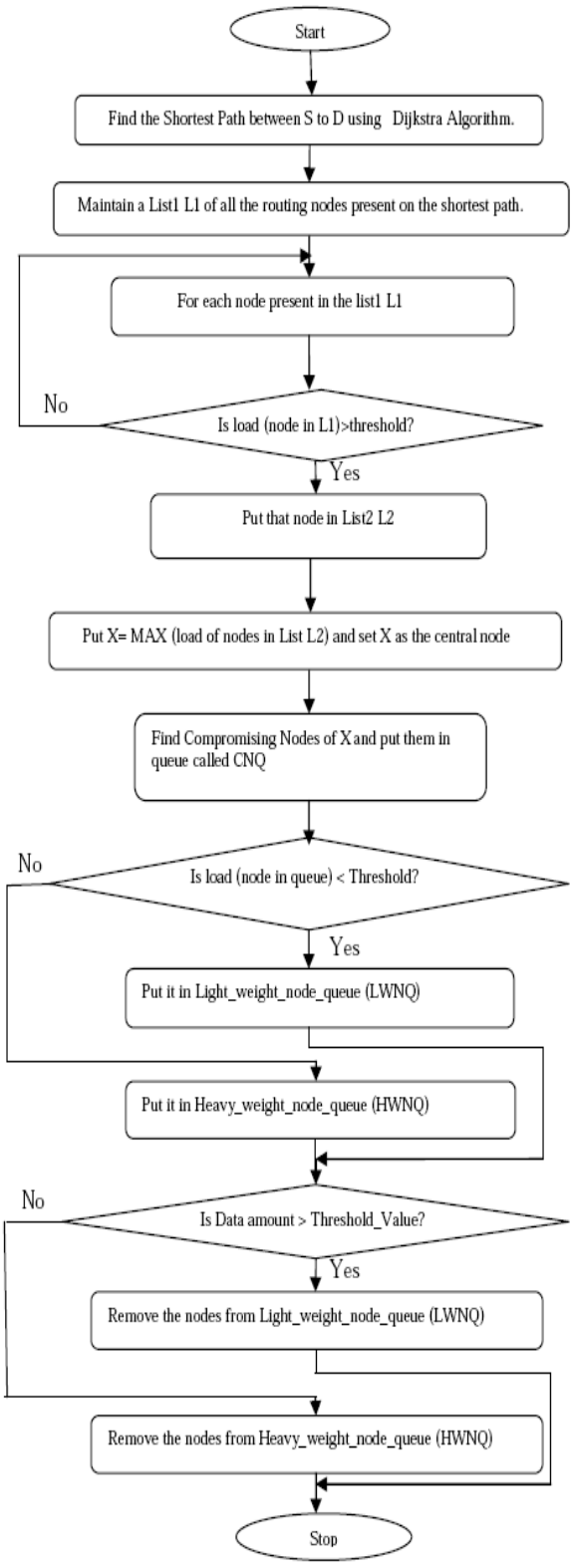
The load distribution algorithm requires two threshold values namely Threshold (This is the maximum value of load assigned to the particular node. And Threshold value is the maximum amount of data to be transmitted over the network.

```
/*Load Distribution Algorithm*/
If(Load(Cq)< Threshold)    /*Quick Sort
Algorithm*/
Put Cq in Light_weight_node_queue LWNQ
Else
Put Cq in Heavy_weight_node_queue HWNQ
If( Amount of data> Threshold_Value)
Remove the nodes from Light_weight_node_queue
and distribute the load on these nodes
Else
Remove the nodes from Heavy_weight_node_queue
and distribute the load on these nodes
```

4.4 Proposed Flowchart



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5. RESULTS

The proposed scheme was implemented using Network Simulator version 2(NS2) [10]. The amount of packets received were recorded for both proposed as well as existing scheme and the graph showing the comparison between both schemes was plotted using X graph as shown in fig 5.

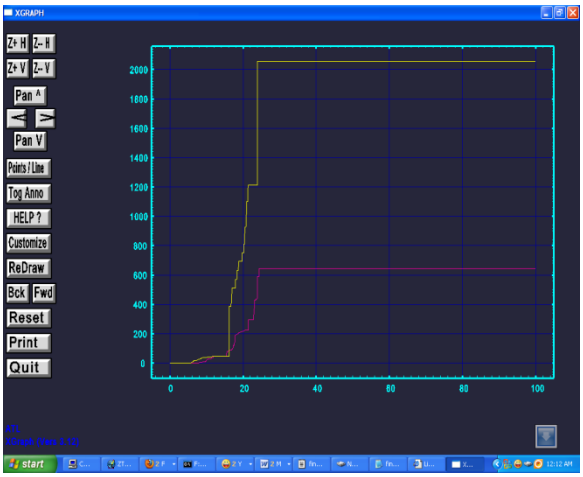

Figure 5: Packet Received (. Proposed vs. existing)

In this, yellow colored line represents proposed system packet received rate which is 2100 while pink colored line represents existing system packet received rate which is 605. Thus, the rate of packet reception is higher in case of proposed system. Similarly, the rate of loss of packets is also measured for both the schemes and the corresponding comparison graph was plotted as shown in fig 6.

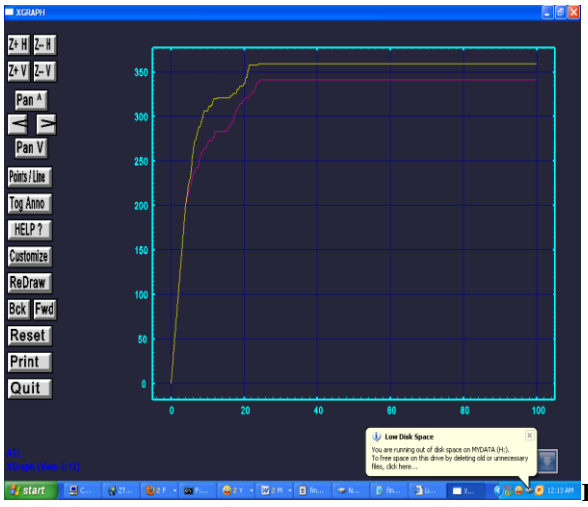

Figure 6 Packet Loss (Existing Vs. Proposed)

In this, yellow colored line represents existing system packet loss which is 355 while pink colored line represents proposed system packet loss which is 330. Therefore, the packet loss in case of proposed algorithm is very less as compared to existing centralized algorithm.

6. CONCLUSIONS AND FUTURE WORK

The Neighboring load balancing algorithm has been proposed as well as implemented on network simulator. It has overcome the drawbacks of existing centralized load balancing strategy. Finally, the workload on central node has been decreased by routing the data packets from surrounding nodes or we can say neighboring nodes. Due to reduction in workload of central node, the rate of packet reception has increased and the rate of packet loss has decreased as compared to existing centralized algorithm. This has lead to the decrease in node failure rate as well as in network congestion thereby increasing the network lifetime.

In future work, there can be clustered approach in Grid Wireless Sensor Network for routing the data. In this we can use clustered network in which the one node act as CH .This CH node collects the data from all neighboring nodes and route this data from source to sink. Using this whole network energy can be minimized.

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