



Load Balancing In Wireless Sensor Networks

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Abstract— spreading the load on the each node of the wireless sensor network leads to enhancing the network performance and also increases the life span of the network. Uneven distribution of load in the network leads to the formation of holes and collapse of network in very short period of time. This paper presents an overview of the load balancing in the wireless sensor network. Various types of algorithm of load balancing is studied and also various load distribution techniques of the WSN.

Keywords— wireless, sensor node, collision, load, balancing

I. INTRODUCTION

Wireless sensor network have received the research attention at present. Wireless sensor networks are connected in such a manner that most of the time they look like a distributed system. It makes the technique of balancing load of a network in order to maximize its throughput. A wireless sensor network consists a base station which communicates with other nodes. Other nodes are used to sense the local environment and send back all information to the other node. Sensing node is composed of low power requirement, reduced functionality, small physical size and small radio coverage area. Wireless sensor network are used in many application such as military and environmental surveillance [2] [3] [5]. Sensing nodes use low battery so minimize the power consumption to extend the life span of the network. In wireless sensor network, energy efficiency is an important metric which directly influence the lifetime of the sensor network.

One approach to meet the requirement of extending the lifetime is to balance the load and for that purpose design an efficient routing algorithm. Load balancing includes the distribution of all the communicational and computational activities over two or more links, nodes or processors present in the network [1] [6]. The main motivation behind load balancing is to reduce the execution time of the load and to make sure that all resources in the network are utilized optimally.

II. RELATED WORK

Previous work in wireless sensor network routing as well as QOS routing in wireless adhoc network largely ignores load balancing issue. Small work is done in load balancing field because it is considered as NP-Hard problem. Hsiao et al [9] designs a rebalancing scheme to achieve load balancing for wireless access networks, though not wireless sensor networks. Flooding is natural for wireless sensor networks but it assumes too much energy on relaying unnecessary data. WU Shu-Ci and NIAN Xiao-Hong [1] concluded that WSN have distinctive feature in network structure and application requirements as compared with the traditional data communication network. As viewed from the hot spots recently routing protocols are analysed and their application and requirements are compared. S.Muthukarpagam and V.Niveditta [2] focuses on various issues such as routing challenges and design issue and quality of service in WSN. Raúl Aquino-Santos, Luis A. Villaseñor-González and Víctor Rangel Licea [3] evaluated all the three routing strategy used in routing in WSN. Results show that source routing only improves the shortest path and hierarchical and geographical routing in terms of the latency.

III. TYPES OF LOAD BALANCING IN WSN

The basic idea behind load balancing is to distribute load on all the computers or nodes which are idle or less utilised. Avoid overloading of some node which results in the degradation of the performance of network and formation of holes in network. Load balancing algorithm can be broadly classified in three categories:

1. Static Algorithm
2. Dynamic Algorithm
3. Adaptive Algorithm

1. Static Algorithm:

In this type of algorithm, all the load balancing decision is hard wired using the prior knowledge of system. All the overhead entailed in the static is almost nil.

2. Dynamic Algorithm:

In dynamic algorithms, we use system state information which includes load on nodes to make load balancing algorithm. Dynamic algorithms have the potential to overcome the limitation of static algorithm. They are able to exploit short term fluctuation in the system to improve system performance. But they include overhead in collection, storage and analysis of system state [4].

3. Adaptive Algorithm:

This type of algorithm is the special type of the dynamic algorithm which adapts their activities by dynamically changing the parameter of the algorithm to suit the changing system state [7].

IV. LOAD DISTRIBUTION TECHNIQUES

There are some techniques which are used in order to distribute the load in the network. These are as follows:

A. Without Center:

In this type of technique routing is done in such a way so that center is avoided to be on the path from source to destination. In cases which doesn't include center node as any node in the path then that path is chosen which is farther from the center node. In this way load on the center node is reduced and the load is distributed on the surrounding nodes.

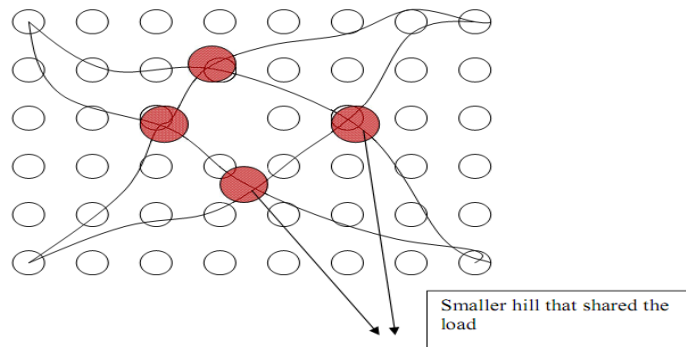


Fig1. Showing load distribution on surrounding nodes.

In this figure load is distributed on the surrounding nodes.

B. Avoiding Center:

In this method the row distance($i-x$) and column distance($j-y$) of a node(i,j) from the center(x,y) is calculated. The path having more distance is selected. If the row distance is larger than or equal to the column distance then the horizontal path is taken otherwise we follow the vertical path. If in case we have center node as any node of that path then this rule is violated and alternative path is taken.[2]

C. Actual Distance From the Center:

In this method, we find out the distance of each node from the center using their coordinates. At every step there are two choices of selecting a node. The node which has more distance from the center will be selected. This procedure is repeated until we reach at the destination.

D. Average Distance From the Center:

In this all those nodes which are the part of path from source to destination, are taken. We find out the average distance of each node from the center along the available two paths. At the end that path is selected which has large average distance.

E. Minimum Distance From The Center:

In this method all the nodes which are the part of the path from the source to the destination are considered. We find out the minimum distance of node from the center along the two given path. The path which has larger minimum distance from the center is selected [8].

V. LOAD BALANCING IN WSN

Routing is a challenging issue for the researchers in the wsn due to the energy constraints in those networks. Deployment methodology also poses challenge in the design of routing strategy [3]. Sensor nodes are deployed either deterministically or randomly on the bases of application for which they are used. For randomly, sensor nodes should be self configuring. In this type of networks, data is transmitted through multihop communication and sensor nodes perform both sending and data routing.[2][9] Inter sense communication is usually short range. Hence, certain amount of energy of each node is spent in forwarding the message to other node.

Mostly central node is heavily loaded in forwarding and routing messages. While the corner nodes are less utilised and due to overload of center node, it discharge rapidly. Center node collapse in very small time and results in formation of holes in the network. Due to collision, holes formation and uneven load distribution, performance of the network degrades and increases of failed messages in the network. So there is a great need to develop a load balancing algorithm which results in the distribution of load of center node to the surrounding nodes [7].

VI. ROUTING STRATEGIES IN WSN

Various routing strategies are developed to balance the load of $N \times N$ grid wireless sensor network.

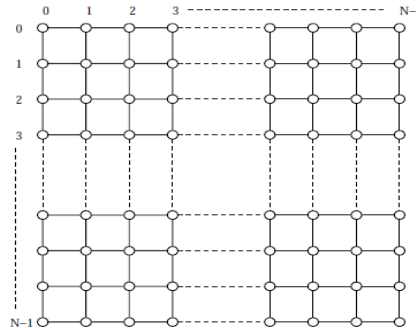


Fig2: Structure of $N \times N$ Grid

Little work is done in developing routing methods which are used in order to balance the load of the network.

A. Servetto Method:

Servetto proposed a spreading algorithm, known as serve to method [5]. This method reduce the load over the center node and increase the load on the corner nodes in single source-single destination communication. This type of method is used on the mesh networks and they claim that it works properly in single source-single destination communication. But when we use the method in all to all communication than center node is found to be heavily loaded node. Whole network is comprised of two stages: expansion and compression stage. In expansion, load per node which is considered as a part of diagonal is reduced. In compression stage load per node increases as it goes towards destination.

B. Horizontal-Vertical Method:

In H-V method message first moves in horizontal direction until it reaches to the intermediate node. After that it moves in vertical direction to reach the destination node. Whenever there is a choice of path between horizontal and vertical path, then horizontal path is taken preference over vertical path [6].

C. Zig-Zag Routing:

In this method message is routed along a path which follows zigzag path. Whenever message can no longer move in zigzag path then message moves either in horizontal or vertical path which one leads to the destination node [3].

VII. CONCLUSIONS

In this paper, we have discussed the need of load balancing in wireless sensor network. Little work is done in balancing load in WSN. We studied the load distribution techniques. Various types of load balancing algorithm are also discussed in this paper. In grid wireless sensor network, center node is found to be overloaded and to remove the collision on center node there are various routing strategies. Load balancing is an important issue. With the help of load distribution we can improve the performance and also increase the life span of the wireless sensor network.

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