Review on Load Balancing in Wireless Sensor Network

Navneet Kaur
M.Tech. Student
Department of Computer Science and Applications
Kurukshetra University, Kurukshetra, Haryana, India

Abstract— — In wireless sensor networks routing is a challenging issue due to hardware constraints such as power, memory and computing capabilities. Wireless sensor networks are a large scale network which consists of thousands of nodes. A sensor manages the task of data sending and routing of data. Due to increases load on nodes, a loss of packet starts which degrade the performance of network. For increases the life time of network and reduce the packet lose equal distribution of load is necessary. Various load balancing strategies are discussed for equal distribution of load in the network.

Keywords— Wireless sensor networks, Load balancing, Sensor node, Applications

I. INTRODUCTION

Wireless sensors networks consist of several hundred of tiny nodes for monitoring physical or environmental conditions such as temperature, humidity, sound levels etc. These sensing devices are responsible for data communication. 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]. Wireless sensor network is one of the most exciting and challenging research areas. Wireless Sensor Networks has foreseen big changes in data gathering, processing and disseminating for monitoring specific applications such as emergency services, disaster management, and military applications etc. However, low sensing ranges results in dense networks

A. Wireless Sensor Network Model

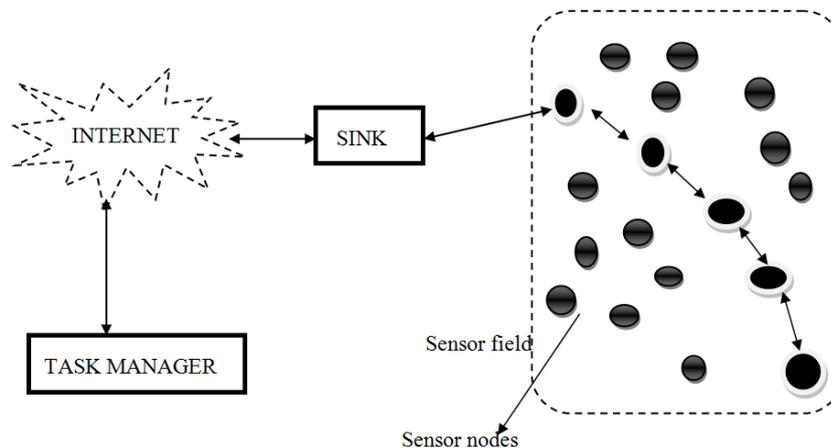The major components of a wireless sensor network are sensor field, sensor nodes, sink and task manager.

Fig-1 Components of a wireless sensor network

Sensor Field: An area in which the nodes are placed.

Sensor Nodes: Sensors nodes are the heart of the network. They perform collecting and routing of data back to a sink.
Sink: A sink is a sensor node with the specific task of receiving, processing and storing data from the other sensor nodes. They serve to reduce the total number of messages that need to be sent; hence reducing the overall energy requirement of the network .The network usually assigns such points dynamically. Regular nodes can also be considered as sinks if they delay outgoing messages until they have aggregated enough sensed information. Sinks are also known as data aggregation points.

Task Manager: The task manager also known as base station is a centralized point of control within the network, which extracts information from the network and disseminates control information back into the network. It also serves as a

gateway to other networks, a powerful data processing and storage centre and an access point for a human interface. The base station is either a laptop or a workstation. Data is streamed to these workstations either via the internet, wireless channels, satellite etc. So hundreds to several thousand nodes are deployed throughout a sensor field to create a wireless multi-hop network. Nodes can use wireless communication media such as infrared, radio, optical media or Bluetooth for their communications. The transmission range of the nodes varies according to the communication protocol is use.

II. WIRELESS SENSOR NETWORKS APPLICATIONS

Sensor networks may consist of many different types of sensors such as seismic, low sampling rate magnetic, visual, thermal, infra-red, acoustic and radar, which are able to monitor a wide variety of ambient conditions . Sensor nodes can be used for continuous sensing, event detection, event ID, and local control of actuators. The concept of micro sensing and wireless connection of these nodes promise many new application areas. We categorize the applications into military; environmental, health and home application.

A. *Military Applications:* Wireless sensor networks can be an integral part of military command, control, communication, computing, intelligence, surveillance and targeting (C4ISRT) systems. The rapid deployment, fault tolerance and self-organization characteristics of sensor networks make them a very promising sensing technique for military (C4ISRT). Since sensor networks are based on dense deployment of disposable and low cost sensor nodes, destruction of some nodes by hostile actions does not affect military applications as much as the destruction of traditional sensor, which makes sensor networks concept a better approach for battlefield.

B. *Environmental Applications:* Some environmental applications of sensor network include tracking the movement of birds, small animals and insects; monitoring environmental conditions that affect crops and livestock, irrigation, macro instruments for large scale earth monitoring and planetary exploration; chemical/biological detection; precision agriculture; biological, Earth and environmental monitoring in marine, soil and atmospheric contexts; forest fire detection and meteorological an d geophysical research; flood detection; bio complexity mapping of the environment and pollution study.

C. *Health Application:* Some of the applications are providing interfaces for the disabled; integrated patient monitoring; diagnostics; drug administration in hospital; monitoring the movements and internal process of insects or others mall animals; telemonitoring of human physiological data; and tracking and monitoring doctors and patients inside a hospital.

D. *Home Applications:* Home automation; as technology advances, smart sensor nodes and actuators can be buried appliances, such as vacuum cleaners, micro wave ovens, refrigerators and VCRs. These sensor nodes inside the domestic devices can interact with each other and with external network via the internet or satellite. They allow end users to manage home devices locally and remotely more easily.[3]

III. LOAD BALANCING

Load balancing is a technique for equal distribution of load across a computer network so that overloading does not take place. Equal distribution of load means workload is equally divided across two or more networks links, cpu and some other resources.
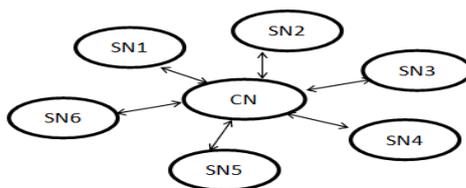Need of load balancing:-
  ➢ To achieve maximum throughput
  ➢ To achieve minimize response time
  ➢ For Congestion free network
  ➢ For optimal resource utilization

  B. *Classification of load balancing strategies:-*
  1) **Local versus global load balancing: -** In local load balancing strategy, stations are divided in to different groups. Each station uses the local information of other stations in its small neighborhood to decide a load transfer for decrease the communication to remote station. To achieve a local balance, a station communicates with its nearest neighbor. Main focuses on share the load on the stations and decreases the communications to remote station.
  In global load balancing strategy deals with global information of all stations to initiate the load balancing.

  2) **Centralized and distributed load balancing:-** In centralized load balancing, central node is heavily utilized in load distribution to other sensor nodes while other nodes are less utilized. Main problem with centralized strategy is that if central node is fails then whole network goes down. This policy works on all to one and one to all communication mode. There is only one master node and all decisions related to load balancing performed by master node. Fig-2 shows centralized load balancing in which CN represents the central node or master node and SN represents the surrounding nodes or slave nodes. In diagram all load balancing decisions performed by central node.

Fig-2 Centralized load balancing

In distributed load balancing, loads are equally distributed among the sensor nodes. There is no master node or central node. Load balancing decision is made by each node. If load balancing is distributed then congestion in the whole network decreases and lifetime of network increases. Packet loss ratio is also decreases in distributed load balancing.

3) **Sender-Initiated or Receiver –Initiated Load Balancing** : In sender-initiated policies [4], congested nodes attempt to move the work to lightly-loaded nodes while in receiver-initiated policies [4], lightly-loaded nodes look for heavily-loaded nodes from which work can be received.

IV.   LITERATURE REVIEW

At present, there have obtained some search results about the load balancing in wireless sensor network such as Servetto and others [5] have presented a routing algorithm which is able to reduce the load on central node because central node will be heavily utilized in routing and forwarding message while other nodes are less utilized. It divides the networks in to two phases. One is expansion phase and another is compression phase. In expansion phase, packet load per node decreases with move across diagonal and in compression phase, packet load per node increases with decrease in no. of nodes on diagonal.

Gupta and others [6] analyzed the sensor nodes can be grouped in to cluster. For load balancing selection of cluster member is necessary. This approach considered the wireless sensor network cluster architecture in advance.

Shah and others [7] have used a kind of multi-path route mechanism, which has energy apperceive capability; make balance the load among the nodes. But the sensor network model, which they used, does not have the flow characteristics of many-to-one.

Perillo and others [8] have used the optimize node transmission distance ways to achieve the load balancing, but all nodes in the sensor network model can communicate directly with the basic station. This case is obviously inconsistent with WSN's characteristics of the multi-hop.

Hsiao and others [9] have constructed the balancing tree for the wireless network which can achieve the load balancing at the highest level among the wireless nodes, but the flow characteristics of WSN and the kinds of wireless networks is different

Dai and others [10] have put forward a node centric load balancing algorithm which uses the grid topology. This approach constructs asymmetric architecture of load balanced tree in wireless sensor network. Tree grows iteratively from lightly loaded nodes to heavily loaded nodes.

Aki and others [11] have proposed a grid based coordinated routing in wireless sensor networks. It is based upon flooding and energy analysis. In this approach region is divided into square shape grid. Coordinator elects per grid based upon the algorithm. This approach also supports the load balancing with equal distribution of load among all the nodes. Energy consumption will reduced when the load is equally balanced among all the nodes.

V.   CONCLUSIONS

In this paper, we review the various load balancing algorithm for wireless sensor networks. In wireless sensor networks network congestion occurs when load exceeds the available capacity at any point in the network. It causes channel quality to degrade and packet loss rates to rise. This uneven load distribution result in heavily loaded nodes to discharge faster when compared to another packet losses and retransmission resulting from congestion cost, precious energy and shorten the lifetime of sensor network. This problem motivates distribute the load among several sensor nodes to avoid network congestion. To balance the node in wireless sensor networks offers a promising improvement in future .

REFERENCES
[1]   Lewis, F.L., "Wireless Sensor Networks Smart Environments: Technologies, Protocols, and Applications",New York: ed. D.J. Cook and S.K. Das, John Wiley, 2004, pp.1-18.

[2] Ian F. Akyildiz, Weilian Su, Yogesh Sankarasubramaniam, and Erdal Cayirci, "A Survey on Sensor Networks", in Proc. of the IEEE Communications Magazine, vol.40, Issue: 8, pp. 102-114, August 2002

[3] I.F. Akyildiz, W.Su, Y.Sankara subramaniam, E.Cayirci, Wireless Sensor Networks: A Survey, Computer Networks 38 (2002) 393-422.

[4] Dandamudi, S, 'Sensitivity Evaluation of Dynamic Load Sharing in Distributed Systems", Technical Report TR 97 -12, Carleton University, Ottawa, Canada.

[5] S. D. Servetto, and G. Barrenechea, "Constrained Random Walks on Random Graphs: Routing Algorithms for Large Scale Wireless Sensor Networks," in Proc. of the 1st ACM international workshop on Wireless sensor networks and applications, pp. 12–21, Atlanta, Georgia, September 2002.

[6] Gupta G, Younis M. "Performance evaluation of load-balanced clustering of wireless sensor networks,". In: Proc.of the 10th Int'l Conf. on Telecommunications (ICT). IEEE Press, 2003. 1577−1583.

[7] Shah RC, Rabaey JM. "Energy aware routing for low energy ad hoc sensor networks,". In: Proc. of the 3rd IEEE Wireless Communications and Networking Conf. (WCNC). Orlando: IEEE Press, 2002. 151−165.

[8] Perillo M, Zhao C, Heinzelman W. "On the problem of unbalanced load distribution in wireless sensor networks,".In: Regency H, ed. Proc. of the IEEE GLOBECOM Workshops on Wireless Ad Hoc and Sensor Networks. Dallas: *IEEE Press, 2004. 74−79.*

[9] Hsiao PH, Hwang A, Kung HT, Vlah D. "Load-Balancing routing for wireless access networks,". In: Bauer F,Cavendish D, eds. Proc. of the 20th Annual Joint Conf. of the IEEE Computer and Communications Societies(INFOCOM). Anchorage: IEEE Press, 2001. 986−995.

[10] Dai H, Han R. "A node-centric load balancing algorithm for wireless sensor networks," In: Proc. of the Global Telecommunications Conf. (GLOBECOM). San Francisco: IEEE Press, 2003. 548−552.

[11] Robert Akl , Uttara Sawant . Grid-based Coordinated Routing in Wireless Sensor Networks.