

**International Journal of Innovative Research in Science,  
Engineering and Technology**

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 4, Special Issue 6, May 2015**

# **Distributed Self-Organized Tree-Based Energy-Balanced Routing Protocol for Wireless Sensor Networks**

V.A.Suresh<sup>1</sup>, P.G.Gopinath<sup>2</sup>

PG Scholar, Department of ECE, GRT Institute of Engineering and Technology, Tiruttani, Tamilnadu, India<sup>1</sup>

Assistant Professor, Department of ECE, GRT Institute of Engineering and Technology, Tiruttani, Tamilnadu, India<sup>2</sup>

**ABSTRACT:** Wireless sensor networks (WSN) have large number of low-cost micro-sensors, which are used to collect and send various kinds of messages to a base station (BS). Wireless sensor nodes are organized randomly and densely in a target area, particularly where the physical environment is so harsh that the macro-sensor counterparts cannot be deployed. WSN consists of low-cost nodes with limited battery power, and replacing battery is complex in thousands of nodes. To solve these problems, many protocols have been proposed. We propose a Distributed Self-Organized Tree-Based Energy Balanced Routing Protocol (DSTEB), which gives a long-life work time and saves energy by balancing WSN load. The proposed approach builds a routing tree using a process where, in each round, BS allots a root node and broadcasts this selection to all sensor nodes. Followed by, each node selects its parent by considering only itself and its neighbors' information. Simulation results show that the proposed approach performs better than other existing approaches in balancing energy utilization, thus increasing the lifetime of WSN.

**KEYWORDS:** Wireless Sensor Network, Load Balance, Network Lifetime, Clustering, Tree Based Routing.

## **I. INTRODUCTION**

Wireless Sensor Networks (WSN) is composed of a hundreds or thousands of micro sensor nodes, which are randomly deployed either inside the phenomenon or very close to it. The micro sensor nodes have capabilities of monitoring, launching wireless communication between each other and doing computational and processing operations. The position of sensor nodes need not be engineered or pre-determined. This permits random deployment in remote terrains or disaster relief operations [1]. Sensor networks have a wide variety of applications and systems with vastly varying requirements and uniqueness. The sensor networks can be used in Military surroundings, Disaster management, Habitat monitoring, Medical and health care, Industrial fields, Home networks, identifying chemical, Biological, radiological, nuclear, and explosive material etc.

In spite of the several applications of WSNs, these networks have numerous limitations, e.g., inadequate energy supply, inadequate computing power, and insufficient bandwidth of the wireless links connecting sensor nodes. The main aim of WSNs is to perform data communication and to extend the lifetime of the network by using energy management approaches. The communication protocols have significant impact on the overall energy dissipation of these networks. Based on our conclusions that the conventional protocols of direct communication, minimum- energy- diffusion, multi-hop routing, and static clustering may not be finest for sensor networks. [2]. Considering the limited battery power capability of an individual sensor, a sensor node can able to sense very small area, so a wireless sensor network has a large number of sensor nodes organize in very high density which reasons for precise problems such as scalability, redundancy. Reducing the amount of data communication by removing unnecessary sensed data and by means of the energy-saving link would save large amount of energy, therefore the lifetime of the WSNs gets increased [3]. In general, WSN may produce large quantity of data, so if fusion could be used, the throughput could be reduced [4]. Fig.1 shows the general LEACH protocol architecture.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

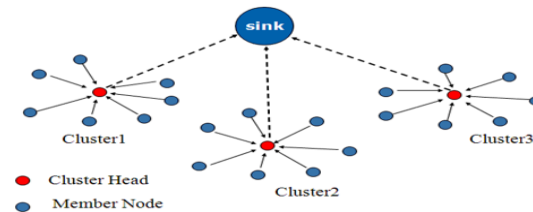


Fig.1 LEACH protocol architecture

The majority of the protocols execute data fusion, but approximately all of them consider that the length of the message transmitted by each communicate node be supposed to be stable [5]. PEGASIS [6], PEDAP [7] and TBC [8] are common protocols based on this consideration and perform better than LEACH [4] and HEED [9] in this case. Fig.2 shows the general PEGASIS architecture.

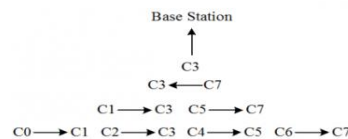


Fig.2 PEGASIS architecture

Hence, several superior techniques that reduce energy inefficiencies that would concentrate the lifetime of the network are highly important. Such constraints combined with a typical deployment of huge number of sensor nodes generate many challenges to the design and management of WSNs and necessitate energy-awareness at all layers of the networking protocol stack. So this paper proposes a distributed self-organized tree-based energy balanced routing protocol to overcome the abovementioned issues in preceding studies.

## II. SURVEY OF ENERGY-EFFICIENT TECHNIQUES

Wireless sensor networks include many recent routing protocols [10] and their classification which are used for the various approaches. There are three main categories are explored, they are data-centric, hierarchical and location-based routing protocols. Each routing protocol is described and discussed under the appropriate category. Moreover, protocols using recent methodologies such as network flow and quality of service modeling are also explained. A routing protocol [11] is introduced to select the routes and to maximize the corresponding battery power level of the nodes. When there is a single power level, the problem is decreased to a maximum flow problem with node capacities and the algorithms converge to the optimal solution. When there are several power levels then the achievable lifetime is close to the optimal (that is computed by linear programming) most of the time. In order to maximize the lifetime of WSN, the traffic should be routed such that the energy consumption is balanced among the nodes in proportion to their energy reserves, instead of routing to minimize the absolute consumed power.

An online-load balanced energy-aware routing protocol (Traffic Aware Energy Efficient Routing Protocol) [12] exploits traffic load information in addition to power residue levels to optimize the load distribution of the entire sensor network, and thus accomplish longer network lifetime. The TAAEE protocol can be adapted to include a random grouping scheme which implements hierarchical routing to reduce computation and routing overhead and to maintain energy efficiency. The TAAEE protocol gives better performance in terms of network lifetime compared with the leading power-aware protocol. The architecture for self-organizing wireless sensor networks [13] connects deeply processors, embedded sensors, and actuators. This combination of wireless and data networking will result in a new form of computational paradigm which is more communication centric than any computer network seen before. Wireless sensor networks are part of a growing collection of information technology constructs which are moving away from the traditional desktop wired network architecture toward a more ubiquitous and universal mode of information connectivity.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

An energy-aware routing protocol [14] is used to reduce the energy consumption of wireless sensor networks using the combination of tree-based minimum transmission energy routing and cluster-based hierarchical routing. The highest residual energy node within  $h$  hops becomes a cluster-head. Therefore the size of each cluster is less than and/or equal to  $h$  hops. Each node can have different energy level the same as real environment and transmits its data to its cluster-head with short distance tree algorithm. Each cluster head sends data to the other cluster-head or the sink with tree-based minimum transmission energy algorithm due to the limit of nodes' transmission range. COSEN (chain oriented sensor network) is used for collecting information efficiently. It is a hierarchal chain-based protocol. COSEN is efficient in the ways that it ensures maximum utilization of network energy, it prolongs lifetime of the network, as well as it requires much lower time to complete a round. The COSEN noticeably gives a good compromise between energy efficiency and latency [15]. Fig.3 shows the general COSEN architecture.

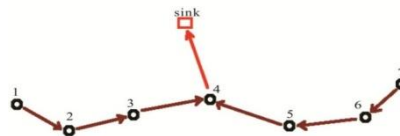


Fig.3 COSEN Architecture

An enhanced logical tree based routing protocol (ELTRP) [17] is used to improve the lifetime of the sensor networks. The ELTRP effectively reduces and balances the energy consumption among the nodes and thus significantly extends the network lifetime. The ELTRP technique outperforms previous method in terms of energy efficiency and network life time. The finest routing protocol [17] is proposed based on Tree-on-DAG (ToD). It is a semi structured strategy that uses Dynamic Forwarding on a totally constructed structure consist of multiple shortest path trees to maintain network scalability. The key standard at the rear of ToD is adjacent nodes in a graph will have low down stretch in one of these trees in ToD, therefore ensuing in early aggregation of packets. A configurable top-down cluster and cluster-tree formation algorithm, a cluster-tree self-optimization phase, a hierarchical cluster addressing scheme, and a routing scheme are used in WSN [18]. The schemes employ features of clusters, cluster tree and routing to prove the efficiency over existing methods. Fig.4 shows the general architecture of cluster-based tree.

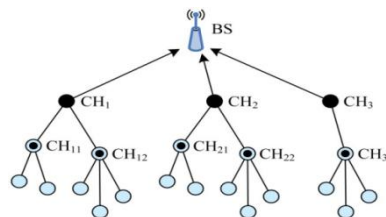


Fig.4 Cluster-based tree architecture

The congestion-based scheduling algorithm [19] is used to reduce delay of data communication. The sensor network is proficient correspond to scheduling that is similar to node-based scheduling. The scheduling algorithm performance is based on the packets distribution at different levels of the routing tree. The congestion-based scheduling algorithm provides the level-based scheduling and evaluation to node-based scheduling is better for topologies that higher density of packets is at the high levels of the tree and alike for topologies that have equal density of packets across the network or higher density of packets at low levels of the tree. Wireless Sensor Networks (WSNs) is a promising structure used to assist the stipulation of many military and industrial services. They have many different constraints, such as computational power, storage capacity, energy supply and etc are the important issue is their energy constraint. Many issues hold back the effectiveness of WSNs to support different applications, such as the resource confines of sensor devices and the finite battery power. A novel tree based routing protocol [20] is used to overcome the problem and to improve the performance need not only to minimize total energy consumption but also to balance WSN load.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

## III. DISTRIBUTED SELF-ORGANIZED TREE-BASED ENERGY-BALANCED ROUTING PROTOCOL

The primary objective of the proposed approach is to attain a longer network lifetime for different applications. In each round, BS allots a root node and broadcasts its ID to all sensor nodes. Then the sensor network decides the path either by transmitting the path information from BS to sensor nodes or by having the same tree structure being dynamically and individually built by each node. For both cases, the proposed system can change the root and reconstruct the routing tree with short delay and low energy consumption. In proposed approach, assume that the system model has the following properties:

- Sensor nodes are randomly distributed in the square field and there is only one BS deployed far away from the area.
- Sensor nodes are stationary and energy constrained. Once installed, they will keep working until their energy is exhausted.
- Sensor nodes are location-aware. Each sensor node can get its location information through other mechanisms such as GPS or position algorithms.
- Each node has its unique identifier (ID).

The proposed method includes four phases:

- A. Initial Phase
- B. Parent Node Selecting Phase
- C. Tree Constructing Phase,
- D. Cycle Phase

### A. Initial Phase

In initial phase, the network parameters are initialized. Then BS broadcasts a packet to all sensor nodes. When all the nodes receive the packet, they will calculate their own energy-level (EL) using function:

$$EL(i) = (residual\_energy(i)) / \alpha \quad (1)$$

Eqn.1 denotes the Energy-Level of each node. EL is a parameter for load balance, and it is an estimated energy value,  $i$  is the ID of each node, and  $\alpha$  is a constant which reflects the minimum energy unit and can be changed depending on our demands.

The sensor nodes broadcast their packet to the network which contains its entire neighbor's information through Token analysis. Initial Phase is an essential preparation for the next phases. After Initial Phase, the proposed approach operates in rounds. Round is not a real time measurement unit, but it imitates the capability for transmitting the sensed data for sensor nodes, so round is an appropriate time measurement unit for WSN lifetime. Each round consists of following phases, including Parent Node Selecting Phase, Tree Constructing Phase and Cycle Phase.

### B. Parent Node Selecting Phase

A node which has more residual energy among all other nodes in the sensor network is selected as parent node and informs all other sensor nodes about the parent node selection. Each node tries to select parent in its neighbors based on energy level and load balancing capacity.

### C. Tree Constructing Phase

The protocol sets the threshold of tree size. The parent node manages tree and forwards data, so it consumes energy faster than other nodes. The number of child nodes cannot exceed the threshold to avoid forming large trees, which will cause extra overhead and thus reduce network lifetime. When the parent node receives Join\_message sent by the ordinary node, it will compare the size of tree with threshold to accept new member and update the count of child nodes if the size is smaller than threshold value, or discard the request. If the rejected node has parent node previously, the tree process stops. Otherwise, it finds another appropriate tree to join.

The parent node selection criterions are:

- i. For a sensor node, the remoteness between its parent node and the base station should be smaller than that between itself and the base station.
- ii. Each node decides a neighbor that guarantees criterion 1 and is the nearest to itself as its parent. If the node can't locate a neighbor which guarantees criterion 1, it decides the base station as its parent.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

iii. The process of Tree Constructing Phase can be observed as an iterative process. Besides criterion 1, for a sensor node, only the nodes with the largest EL can act as transmit nodes. If the sensor node itself has the largest EL, it can also be considered to be an imaginary transmit node. Choosing the parent node from all the transmit nodes is based on energy utilization. The transmit node which causes least energy utilization will be chosen as the parent node. So a path with lowest energy consumption is found by iterations. And by using EL, the proposed system selects the nodes with high residual energy to transmit data for long distance. If the sensor node cannot find a suitable parent node, it will deliver its data directly to BS.

iv.

Every node selects the parent from its neighbors and every node stores its neighbors' information, each node identifies all its neighbors' parent nodes, and all its child nodes. If a node has no child node, it describes itself as a leaf node, and then the data transmission starts. Each packet sent to the parent nodes will be fused, the least energy consumption can be achieved if each node selects the nearest node as parent node. But if all nodes select their nearest neighbors, the network cannot be able to construct a tree.

The tree constructing phase includes two types of techniques. They are,

1. K-hop Connectivity ID Algorithm, and
2. Self-Organized Tree Formation (Master and Slave).

### 1. K-Hop Connectivity ID Algorithm (KCONID)

In order to elect the parent node connectivity is considered as a high priority and lower ID as a low priority. Using only connectivity origins several links between nodes. On the other hand, using only a lower ID creates more unnecessary trees. The main aim is to reduce the number of trees formed in the network and by this way we achieve controlling sets of smaller size trees. Trees in the KCONID approach are formed by a parent node and all nodes that are at distance at most k-hops from the parent node. K-CONID generalizes connectivity for a k-hop neighborhood. Thus, when  $k = 1$  connectivity is the same as node degree. Each node in the network is assigned a pair = (d, ID). d denotes node's connectivity and ID denotes the node's identifier. A node is selected as a parent node if it has the highest connectivity. In case of equal connectivity, a node has parent node priority if it has lowest ID [21].

### 2. Self-Organized Tree Formation (Master And Slave)

In order to conserve energy and for effective data transmissions in wireless sensor networks master and slave techniques are used [22]. There are two types of nodes, master (parent node) and slave (child node). The node within a tree can able to move outside from its specified range. so the nodes which come outside from its range will form a self-organized tree and again it selects a parent node to transfer data. Hence there will be no data loss. The master node is the parent node so the master node alone connects to the sink and slave node is a child node and hence there is no direct link to the sink. So the slave node had to use master node to send data to the sink. Fig.5 shows the Self-Organized Tree (Master and Slave)

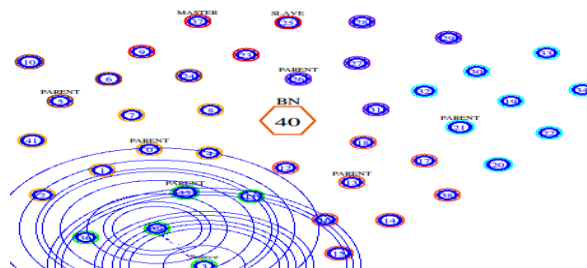


Fig.5 Master and Slave

### D. Cycle Phase

The cycle phase includes two methods. They are,

1. Reelection of parent nodes, and
  2. Detection of malicious nodes
1. Re-Election of Parent Node

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

After parent nodes send data to the sink we are going to reelect the parent nodes for next data transmissions. While sending a data the parent can lose its energy. So we are going to reelect the parent for further transmissions. The node which has more residual energy among all other nodes is reelected as parent node for next round. The current parent node gathers the weight of all other nodes in the network, and then elects the node with highest residual energy as the next parent node. In this way, the communication costs are decreased. Fig.6 shows the trees with re-elected parent nodes.

## 2. Detection of Malicious Node

Some malicious give misbehaved communication signal, not give proper signal strength. Tree based Certificate revocation for enlisting and removing the certificates of nodes that have been detected to launch attacks on the neighborhood. Finally, sensor nodes recognized and protect the sensor nodes from malicious attack. Fig.7 shows the detected malicious nodes among all the sensor nodes.

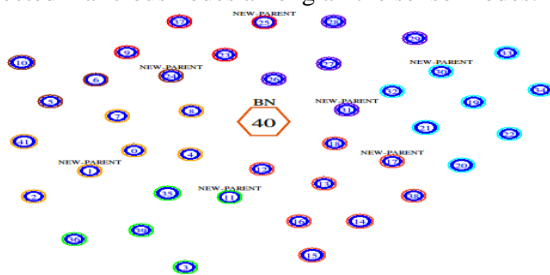


Fig.6 Reelection of parent node.

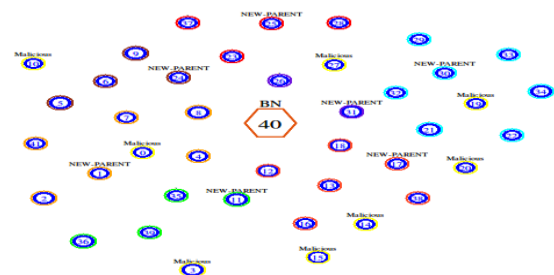


Fig.7 Detection of malicious node

## IV. RESULTS AND DISCUSSION

The Network Simulator version 2.0 (NS2) simulation of the proposed approach is done to evaluate the performance. The lifetime of a wireless sensor network is constrained by the limited energy and unbalanced network load. To improve the lifetime of the wireless sensor networks it is very important to have high energy efficiency and balancing network load.

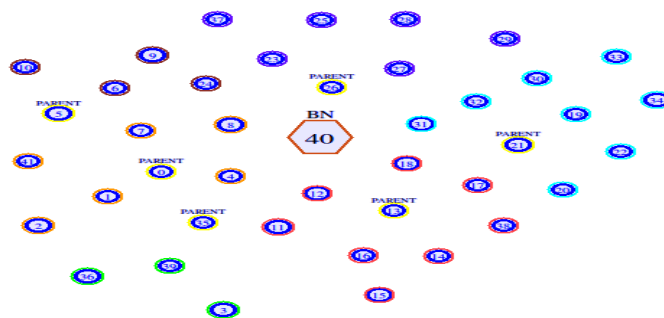


Fig.8 Tree generated by DSTEB for 42 nodes randomly deployed in an area.

Fig.8 shows that the DSTEB organizes the nodes that are randomly deployed in an area into tree.

Performance metrics: The performance of the proposed protocol is compared with existing protocol. The performance is evaluated mainly according to following metrics.

*Throughput:* It is the amount of packets successfully received by the receiver during the data transmission.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

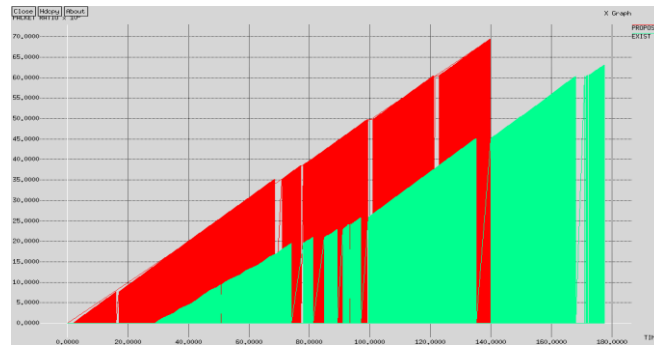


Fig.9 Throughput comparison of Routing Protocols

The graphical representation of throughput comparison is shown in the fig 9. The graph shows that the DSTEB protocol is better than the existing protocols such as GSTEB (General Self-Organized Tree-Based Energy Balanced Routing Protocol). The throughput is healthier when compared with existing algorithms such as GSTEB, LEACH and PEGASIS.

*Delay ratio:* It is average delay taken by the nodes during data transmission

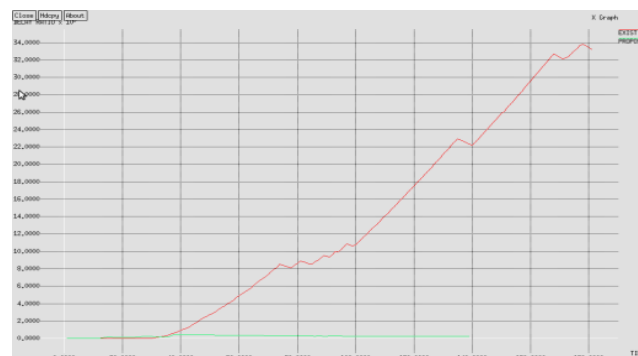


Fig.10 Delay ratio comparison of Routing Protocols

The graphical representation of delay ratio comparison is shown in the fig 10. The graph shows that the DSTEB protocol is better than the existing protocols such as GSTEB (General Self-Organized Tree-Based Energy Balanced Routing Protocol). The delay ratio is lesser when compared with existing algorithms such as GSTEB, LEACH and PEGASIS.

*Packet drop:* It is the amount of packets dropped during the data transmission.

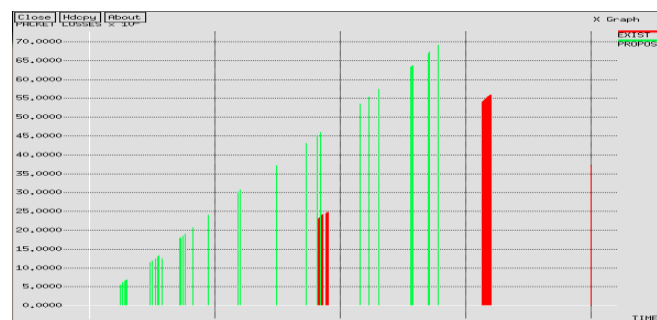


Fig.11 Packet drop ratio comparison of Routing Protocols

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

The graphical representation of packet drop ratio comparison is shown in the fig 11. The graph shows that the DSTEB protocol is better than the existing protocols such as GSTEB (General Self-Organized Tree-Based Energy Balanced Routing Protocol). The packet drop ratio is lesser when compared with existing algorithms such as GSTEB, LEACH and PEGASIS.

*Packet delivery ratio:* It is the number of packets successfully sent during the data transmission.

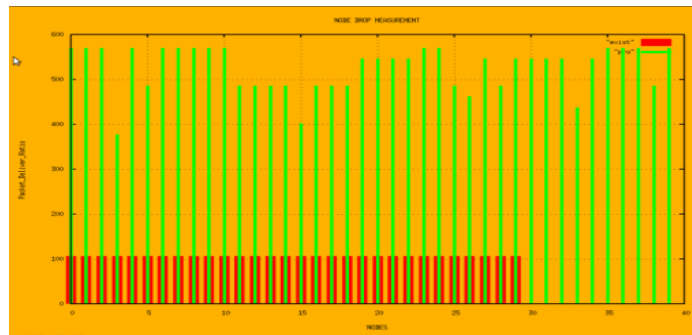


Fig.12 Packet delivery ratio comparison of Routing Protocols

The graphical representation of packet delivery ratio comparison is shown in the fig 12. The graph shows that the DSTEB protocol is better than the existing protocols such as GSTEB (General Self-Organized Tree-Based Energy Balanced Routing Protocol). The packet delivery ratio is healthier when compared with existing algorithms such as GSTEB, LEACH and PEGASIS.

*Protocol working frequency:* It shows that how the DSTEB protocol was efficiently working than the other existing protocols.

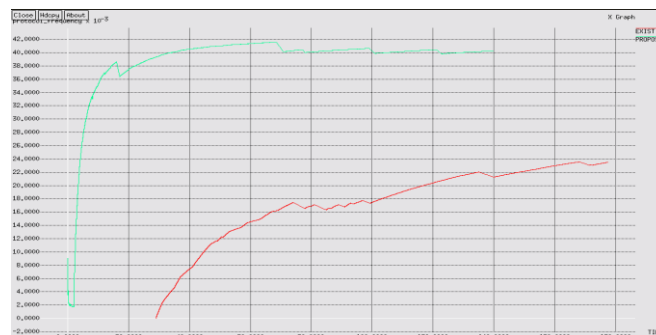


Fig. 13 Protocol working frequency comparison of Routing Protocols

The graphical representation of protocol frequency comparison is shown in the fig 13. The graph shows that the proposed protocol is better than the existing protocols such as GSTEB (General Self-Organized Tree-Based Energy Balanced Routing Protocol). The protocol working frequency is better when compared with existing algorithms such as GSTEB, LEACH and PEGASIS.

## V. CONCLUSION

The NS2 simulations show that when the data collected by sensors is strongly correlative, the DSTEB protocol outperforms GSTEB, LEACH and PEGASIS. Because the proposed protocol is a self-organized protocol, it only consumes a small amount of energy in each round to change the topography for the purpose of balancing the energy consumption. All the leaf nodes can transmit data in the same TDMA time slot so that the transmitting delay is short. The proposed approach offers another simple approach to balancing the network load. In fact, it is difficult to distribute



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

the load evenly on all nodes.

## REFERENCES

- [1] Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Network," Copyright @ 2005 John Wiley & Sons, Ltd.
- [2] W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy efficient Communication Protocols for Wireless Micro-Sensor Networks," in Proc. 33rd Hawaii Int. Conf. System Sci., Jan. 2000, pp. 3005–3014.
- [3] M. Liu, J. Cao, G. Chen, and X. Wang, "An Energy-Aware Routing Protocol in Wireless Sensor Networks," Sensors, vol. 9, pp. 445–462, 2009.
- [4] W. B. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "An Application- Specific Protocol Architecture for Wireless Microsensor Networks," IEEE Trans. Wireless Commun, vol. 1, no. 4, pp. 660–670, Oct. 2002.
- [5] W. Liang and Y. Liu, "Online Data Gathering for Maximizing Network Lifetime in Sensor Networks," IEEE Trans Mobile Computing, vol. 6, no. 1, pp. 2–11, 2007.
- [6] S. Lindsey and C. Raghavendra, "PEGASIS: Power-Efficient Gathering In Sensor Information Systems," in Proc. IEEE Aerospace Conf., 2002, vol. 3, pp. 1125–1130.
- [7] H. O. Tan and I. Korpeoglu, "PEDAP: Power Efficient Data Gathering And Aggregation In Wireless Sensor Networks," SIGMOD Rec., vol. 32, no. 4, pp. 66–71, 2003.
- [8] K. T. Kim and H. Y. Youn, "Tree-Based Clustering (TBC) for Energy Efficient Wireless Sensor Networks," in Proc. AINA 2010, 2010, pp. 680–685.
- [9] O. Younis and S. Fahmy, "HEED: A Hybrid, Energy-Efficient, Distributed Clustering Approach For Ad Hoc Sensor Networks," IEEE Trans. Mobile Computing, vol. 3, no. 4, pp. 660–669, 2004.
- [10] K. Akkaya and M. Younis, "A Survey Of Routing Protocols in Wireless Sensor Networks," Elsevier Ad-Hoc Network J., vol. 3/3, pp. 325–349, 2005.
- [11] J. H. Chang and L. Tassiulas, "Energy Conserving Routing In Wireless Ad Hoc Networks," in Proc. IEEE INFOCOM, 2000, vol. 1, pp. 22–31.
- [12] G. Mankar and S. T. Bodkhe, "Traffic Aware Energy Efficient Routing Protocol," in Proc. 3rd ICECT, 2011, vol. 6, pp. 316–320.
- [13] Sohrabi et al., "Protocols for Self-Organization of a Wireless Sensor Network," IEEE Personal Commun., vol. 7, no. 5, pp. 16–27, Oct. 2000.
- [14] Backhyun Kim and Iksoo Kim, "Energy Aware Routing Protocol in Wireless Sensor Networks" IJCSNS International Journal of Computer Science and Network Security, VOL.6 No.1, January 2006.
- [15] N. Tabassum, Q. E. K. Mamun, and Y. Urano, "COSEN: A Chain Oriented Sensor Network for Efficient Data Collection," in Proc. IEEE ITCC, Apr. 2006, pp. 262–267.
- [16] N. Suma, Dr. T. Purusothaman, "ELTRP: Enhanced logical tree based routing protocol for energy efficient wireless sensor networks," IJAIST International Journal of Advanced Information Science and Technology, Vol.8, No.8, December 2012.
- [17] Prakash G L, Thejaswini M, S H Manjula, K R Venugopal, L M Patnaik "Tree-on-DAG for Data Aggregation in Sensor Networks" World Academy of Science, Engineering and Technology Vol:3, pp.675-681, 2009.
- [18] H.M. N. Dilum Bandara, Anura P. Jayasumana, and Tissa H. Illangasekare "A Top-Down Clustering and Cluster-Tree-Based Routing Scheme for Wireless Sensor Networks" International Journal of Distributed Sensor Networks Volume 2011, Article ID 940751, 17 pages.
- [19] Vahid Zibakalam "A New TDMA Scheduling Algorithm for Data Collection over Tree- Based Routing in Wireless Sensor Networks" International Scholarly Research Network ISRN Sensor Networks Volume 2012, Article ID 864694, 7 pages.
- [20] M. Sengaliappan, A. Marimuthu "Improved General Self-Organized Tree-Based Routing Protocol for Wireless Sensor Network" Journal of Theoretical and Applied Information Technology, 10<sup>th</sup> October 2014. Vol. 68 No.1.
- [21] Ratish Agarwal and Dr. Mahesh Motwani "Survey of clustering algorithms for MANET" International Journal on Computer Science and Engineering Vol.1(2), 98-104, 2009.
- [22] Jane Y. Yu and Peter H.J. Chong, Nanyang "A survey of clustering schemes for mobile adhoc networks" volume 7, no. 1, 2005.