Enhanced the LEACH Protocol for Minimization of Energy Utilization in Wireless Sensor Network

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Abstract

Energy utilization is major issue in wireless sensor network. The wireless sensor network is diverse network to deploy for collection of critical information in geospatial location. The sensor network basically used tiny battery for uses of energy. The maximum consumption of energy expires the life of network. For the improvement of life cycle of sensor network used energy based routing protocol. in series of energy based routing protocol such as LEACH, QLEACH and many more routing protocols. The LEACH protocol basically based on the clustering technique. the cluster head during the communication change it take more energy.

In this dissertation modified the QLEACH protocol for the minimization of energy utilization in wireless sensor network. For the minimization of energy used EM model. The EM model basically probability based function. The EM function estimation the Value of energy for the communication. The proposed method made in two factor one is measurement of power during formation of cluster head and in second phase used the process of data aggregation with sensor node. The deployment model of sensor node is distributed in different section. The distribution of these sensor node in random fashion according to mobility model of senor network.

Keywords: - ***WSN, Energy, Energy Consumption LEACH, Probabilistic Model, Q- LEACH.***

INTRODUCTION

Wireless Sensor Network (WSN) is a popular and have capability to high penetrate with several applications areas. It consists of small nodes having limited sensing, computation, and wireless communications capabilities. Sensor nodes normally sensed data and forward sensed data to the base station such as temperature, sound, vibration, pressure, motion or pollutants[1-2]. Sensor nodes are resource constraint type of network and contain very tiny size of irreplaceable and not chargeable batteries WSN network is divided into sub networks\clusters and each cluster has cluster head which is responsible to collect the sensed data from his cluster and forward it to the base station. WSN is the only most suitable and easy way of deployment in remote and hard areas. Routing is the main expensive operation for nodes energy consumption [6-8].

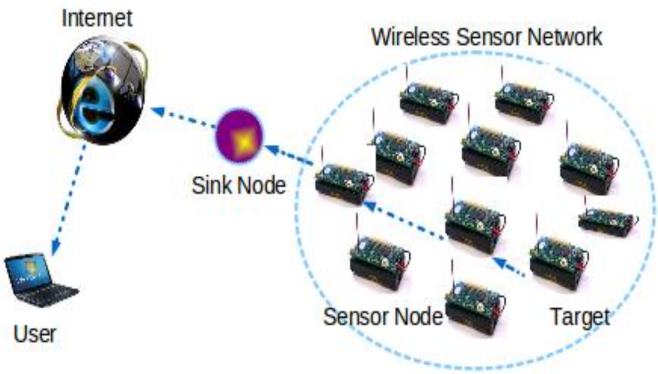

Figure 1: Wireless Sensor Network

Wireless Sensors are subjected to harsh deployment conditions and have constrained resources. In this paper, the effectiveness of LEACH protocol in extending the lifetime for energy-constrained wireless sensor networks [4]. Based on LEACH protocol Low Energy Adaptive Clustering Hierarchy (LEACH) partitions the nodes into clusters, in each cluster a dedicated node with extra privileges called Cluster Head (CH) is responsible for creating and manipulating a TDMA (Time division multiple access) schedule and sending aggregated data from nodes to the Base Station. Remaining nodes are cluster members. This protocol is divided into rounds; each round consists of two phases [8-11];

Set-up Phase
(1) Advertisement Phase
(2) Cluster Set-up Phase
Steady Phase
(1) Schedule Creation
(2) Data Transmission

The rest of paper discuss in section II Q-Leach. In section III discuss modified protocol. in section IV discuss experimental result and finally discuss conclusion and future work in section V.

II. Q- LEACH

In this section discuss pervious Q-LEACH algorithm process. They discuss network characteristics and working principle of proposed scheme for efficient performance. In order to enhance some features like clustering process, stability period and network life-time for optimized performance of WSNs. According to this approach sensor nodes are deployed in the territory. In order to acquire better clustering, we partition the network into four quadrants. Doing such sort of partitioning better coverage of the whole network is achieved[5-7]. Additionally, exact distribution of nodes in field is also well defined. Describes optimal approach of load distribution among sensor nodes. Moreover, it also presents an idea of efficient clustering mechanism which yields significantly in better coverage of whole network[15-16]. We deployed random nodes in a 100m×100mfiled. Based on location information, network is divided into four equal parts i.e, (a1, a2, a3, a4). Defining overall network area as below:

$$A = a1 + a2 + a3 + a4 \ldots\ldots (1)$$

$$an = A(xm, ym) \ldots\ldots\ldots\ldots (2)$$

Where, n = 4. And m = 100. Hence, overall field is distributed as follows:

Ym=0:50 lim Xm=0:50 an + Ym=0:50 limXm=51:100 an +Ym=51:100limXm=0:50an +Ym=51:100

limXm=51:100an ……....(3)

Portioning of network into quadrants yields in efficient energy utilization of sensor nodes. Through this division optimum positions of CHs are defined. Moreover, transmission load of other sending nodes is also reduced[13]. In conventional LEACH cluster are arbitrary in size and some of the cluster members are located far away. Due to this dynamic cluster formation farther nodes suffers through high energy drainage and thus, network performance degrades. Whereas, in Q-LEACH network is partitioned into sub-sectors and hence, clusters formed within these sub-sectors are more deterministic in nature. Therefore, nodes are well distributed within a specific cluster and results in efficient energy drainage. Concept of randomized clustering as given in [12] for optimized energy drainage is applied in each sector. Assigning CH probability P = 0.05 we start clustering process.

Overall network is divided into four areas as: Area A, B, C and D. Initially each node decides whether or not to become a CH. Node chooses a random number between 0 and 1[14]. If this number is less then certain threshold T (n), and condition for desired number of CHs in a specific area is not met, then the node becomes a CH. Similarly, the same process continues for rest of the sectors and optimum number of clusters is formed. Selection of clusters will depend upon Received Signal Strength Indicator (RSSI) of advertisement. After decision of clusters, nodes must tell CHs about their association. On the basis of gathered information from attached nodes, guaranteed time slots are allocated to nodes using Time Division Multiple Access (TDMA) approach. Moreover, this information is again broadcasted to sensor nodes in the cluster. Algorithm.2 defines association of nodes with their appropriate CHs. Non-CHs nodes will locate themselves in specified area they belong to. Then they will search for all possible CHs, and on the basis of RSSI they will start association. This process will continue until association phase comes to an end. Once cluster setup phase is complete and nodes are assigned with TDMA slots every node communicates at its allocated time interval. Rest of the time radio of each non-cluster head node will remain off in order to optimize energy utilization. When all nodes data is received at the CHs then, the data is compressed and is sent to BS. The round completes and new selection of CHs will be initiated for next round. In proposed idea, we implement above mentioned concept of localized coordination in each sectored area. We used same radio model as discussed in [1] for transmission and reception of information from sensor nodes to CHs and then to BS. Packet length K of 2000 bits is used in our simulations. According to above mentioned flow chart, initially all nodes send their location information to BS. BS performs logical partitioning of network on the basis of gathered information. Network is divided into four quadrants and broadcasts information to nodes. On the basis of threshold some nodes are elected as CH in each division. Normal nodes choose their CHs within their own quadrant based on RSSI. For association nodes sends their requests to CHs. TDMA slots are assigned to every node for appropriate communication without congestion.

III. MODIFIED PROTOCOL

In this section discuss the improved protocol of Q-LEACH protocol. The Q-LEACH protocols not measure the prior knowledge of cluster head selection during transmission of data for base station. The selection of cluster head process done by using EM estimation technique. The EM technique estimate the energy level and consumption level during transmission and selection of cluster node in individual cluster group. The process of individual group of nodes for selecting the cluster head depends on minimum energy required for the formation process. Now process of that reduces the energy consumption and increase the life time of the network. In each area of cluster head selection using the grouping of node using estimation of maximum entropy for the generation of information during selection of cluster head and data aggregation for the transmission of data form sensor node to base station. The working algorithm discuss in two phases in first phase discus the estimation technique of energy and second phase discuss the process of data aggregation of algorithm.

Steps of algorithm

1: Assign values to the coefficients W_1, W_2, W_3, W_4, W_5;

2: For any node $n_i \in$ G make:

3: n_i forms a list of its neighbors $N(i)$ through the Message $\{who\_are\_neighbors\}$;

4: $N(i) = \varphi$;

5: Calculate its energy P_i :

6: $P_i = w_1 * B\,L_1 + w_2 * B\,L_2 + w_3 * B\,L_3 + w_4 * B\,L_4 + w_5 * B\,L_5$;

7: Initialize EM factor of all nodes $n_i \in$ G

$Vector\_State\ (Id, CH, Weight,\ List\_Neighbors, Size, Nature)$

8: $CH = 0, Size = 0$;

9: $Nature = \text{“}None\text{”}$;

10: $\boldsymbol{Repeat}$

11: Any node $n_i \in$ G $Broadcasts\ a\ message\ \text{"}Hello\text{"}$;

12: $\boldsymbol{If\ N(i)\ <>\ \varphi\ Then}$

13: Choose $v \in N(i)$;

14: $\boldsymbol{Weight(v) = max\,\{weight(w)\,/\,w \in N(i)\}}$;

15: $\boldsymbol{Else}$ n_i is a CH of itself.

$\boldsymbol{EndIf}$

16: Update the state vector of the elected CH;

17: CH = ID;

18: Size = 1;

19: Nature = CH;

20: Send the message “CH_{msg}” by CH to its neighbors $(N[CH])$;

21: $J = Count\ (N\,[CH])$;

22: $\boldsymbol{For}\ I = 1\ to\ J\ \boldsymbol{Do}$

23: $If\ (n_i \in N\,[CH]\ receives\ the\ message\ \&\&\ n_i \rightarrow CH = 0)$

24: $\boldsymbol{Then}\ n_i\ sends\ a\ message\ \text{“}JOIN_{msg}\text{”}\ to\ CH$

25: $If\ (CH \rightarrow Size < THRESHOLD\_MAX\ )$

26: $Then\ CH\ sends\ a\ message\ \text{“}ACCEPT_{msg}\text{”}\ to\ Node\ n_i$;

27: $CH\ executes\ the\ accession\ process$;

28: $CH \rightarrow Size = CH \rightarrow Size + 1$;

29: $n_i\ executes\ the\ accession\ process$;

30: $ni \rightarrow CH = CH \rightarrow Id$;

31: $\boldsymbol{Else}\ go\ to\ 10$;

$\boldsymbol{EndIf}$

$\boldsymbol{EndIf}$

$\boldsymbol{End\ For}$

32: $Until\ (CH \rightarrow Size = THRESHOLD_{MAX})or\ expired\ (Time\_Cluster)$;

$\boldsymbol{End.}$

IV. EXPERIMENTAL ANALYSIS

In this section evaluate the performance of improved energy based routing protocol simulated in MATLAB software. For the evaluation of performance simulate also two algorithm one is LEACH protocol and Q Leach protocol. the measuring the various parameter such as PDR, delivery ratio and some other.

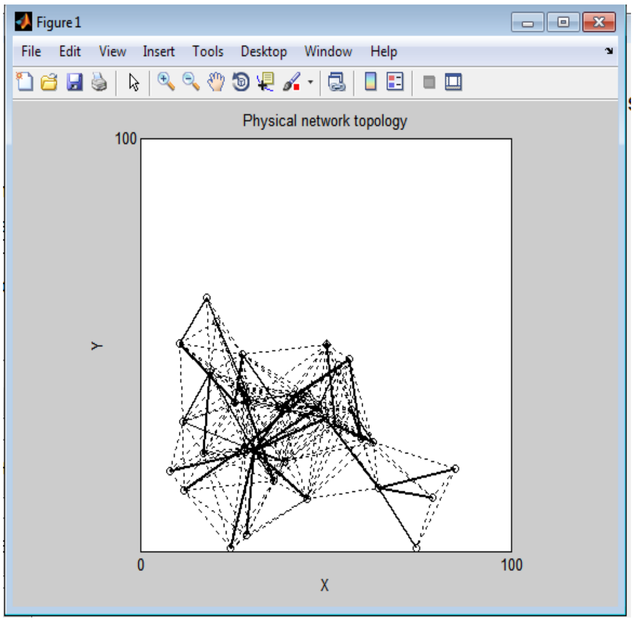

Figure 2: window show the output result of LEACH method using number of node, number of maximum child and depth of network in our energy efficient routing protocol for WSN implementation.

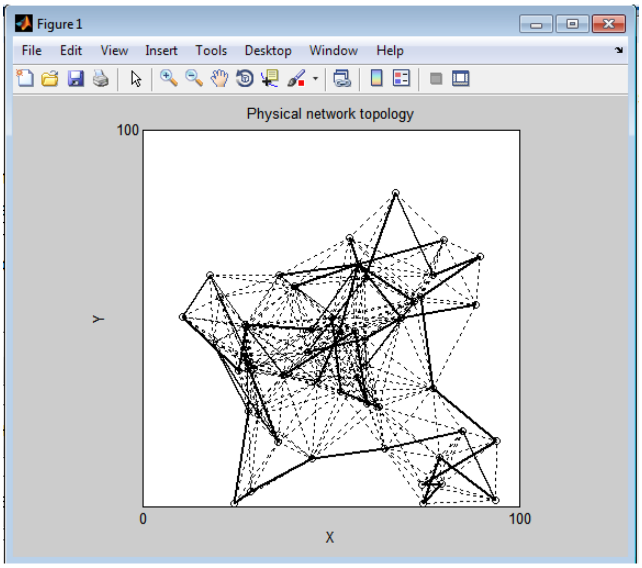

Figure 3: window show the output result of Q-LEACH method using number of node, number of maximum child and depth of network in our energy efficient routing protocol for WSN implementation.

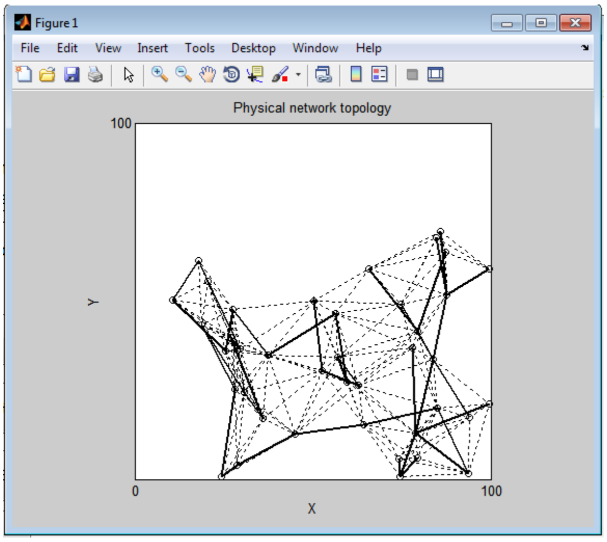

Figure 4: window show the output result of Proposed method using number of node, number of maximum child and depth of network in our energy efficient routing protocol for WSN implementation.

METHOD	PDR	Routing Overhead	End to End Delay	Hop-Count
Leach	0.1567	300	0.5500	470
Q-Leach	0.2567	280	0.1500	460
Proposed	0.3567	270	0.0500	455

Table 1: Shows the comparative evaluation of Leach method, Q-Leach method and Proposed method.

METHOD	PDR	Routing Overhead	End to End Delay	Hop-Count
Leach	0.7740	100	0.0059	774
Q-Leach	0.8740	80	0.3941	764
Proposed	0.9740	70	0.5941	759

Table 2: Shows the comparative evaluation of Leach method, Q-Leach method and Proposed method.

METHOD	PDR	Routing Overhead	End to End Delay	Hop-Count
Leach	0.4900	200	0.0082	980
Q-Leach	0.5900	180	0.3918	970
Proposed	0.6900	170	0.5918	965

Table 3: Shows the comparative evaluation of Leach method, Q-Leach method and Proposed method.

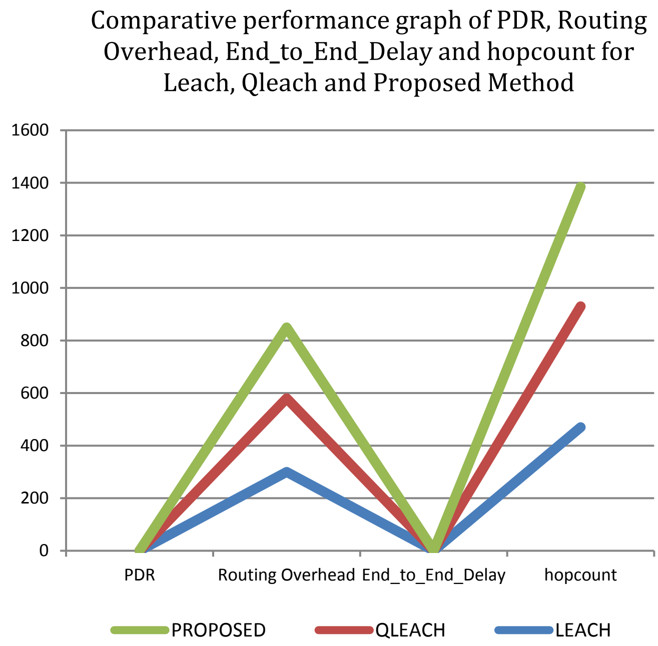

Figure 5: Shows the comparative performance of PDR, Routing Overhead, End_to_End_Delay and Hopcount

using Leach, Qleach and Proposed Method with input value of number of node, number of maximum child (cm) and depth of network (LM).

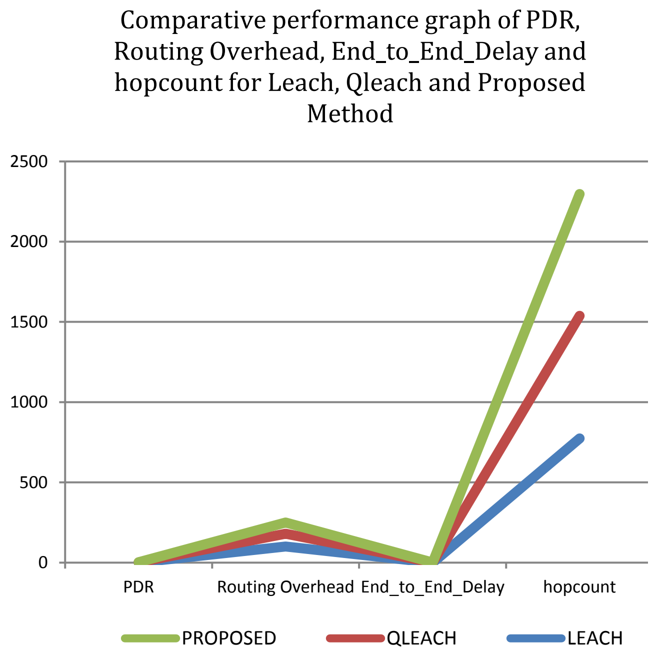

Figure 6: Shows the comparative performance of PDR, Routing Overhead, End_to_End_Delay and Hopcount using Leach, Qleach and Proposed Method with input value of number of node, number of maximum child (cm) and depth of network (LM).

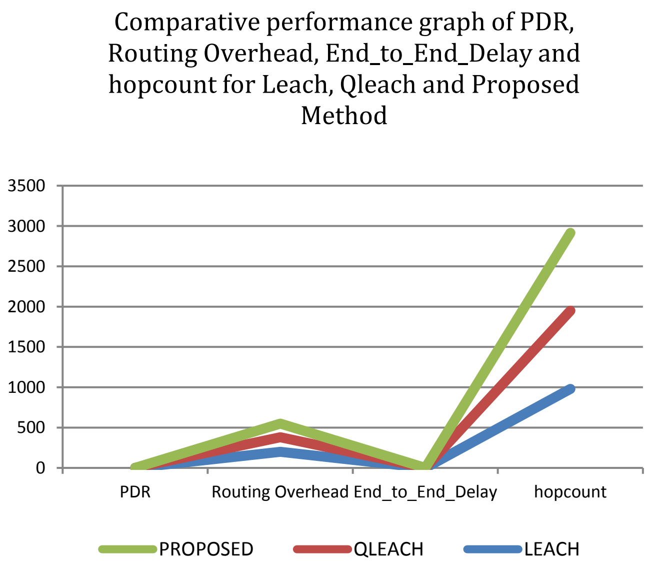

Figure 7: Shows the comparative performance of PDR, Routing Overhead, End_to_End_Delay and Hopcount using Leach, Qleach and Proposed Method with input value of number of node, number of maximum child (cm) and depth of network (LM).

V. CONCLUSION & FUTURE SCOPE

This dissertation provides minimization of energy for wireless sensor network in concern of power consumption and life time of network. The proposed models give a better energy utilization factor for wireless sensor network. The proposed model M-Q-LEACH implies in two section one is base node and another node as sensor. The sensors end request for communication for next node in installed location of BS.

The proposed model M-Q-LEACH estimate communication power loss rate of vehicle ad-hoc network with data powers, form Experimental results we can conclude: Power loss rate of WSNs is affected by a number of factors, such as flooding of control message protocol and M-Q-LEACH is an accurate model to estimate power loss rate, due to its stable and clear filtration process, its PDF is more accurate, and maximum a posteriori algorithm is less complexity and share good real-time performance.

M-Q-LEACH can estimate the communication package loss rate with a smaller error, and can track the tiny change about it. It can be used to grasp the overall characteristics of the communication, support the data transmission control and routing algorithms in network protocol.

The diversity of network and service oriented traffic in wireless sensor network further explored our research work in term of calculation of power node assignment, for the process as base node for controlling a message request of all mobile sensor node in communicating network. The filtration process used huge amount of power for the process of selection, now need some extra memory segment for the process of EM. Now exploding of this works and optimized the process of reference node allocation and reduces the capacity of memory for the expanding of power allocation.

References

[1] Kai Han, Jun Luo, Yang Liu and Athanasios V. Vasilakos "Algorithm Design for Data Communications in Duty-Cycled Wireless Sensor Networks: A Survey∗", IEEE, 2013, Pp 1-7.

[2] Joaquim Oller, Ilker Demirkol, Jordi Casademont, Josep Paradells, Gerd Ulrich Gamm and Leonhard Reindl "Has Time Come to Switch from Duty-Cycled MAC Protocols to Wake-up Radio for Wireless Sensor Networks?", IEEE, 2014, Pp 1-15.

[3] Shuo Guo, Liang He, Yu Gu, Bo Jiang and Tian He "Opportunistic Flooding in Low-Duty-Cycle Wireless Sensor Networks with Unreliable Links", IEEE, 2014, Pp 2787-2802.

[4] Rashmi Ranjan Rout and Soumya K. Ghosh "Enhancement of Lifetime using Duty Cycle and Network Coding in Wireless Sensor Networks", IEEE, 2013, Pp 656-667.

[5] Euhanna Ghadimi, Olaf Landsiedel, Pablo Soldati and Mikael Johansson "A Metric for Opportunistic Routing in Duty Cycled Wireless Sensor Networks", IEEE, 2012, Pp 1-9.

[6] Chunsheng Zhu, Laurence T. Yang, Lei Shu, Victor C. M. Leung, Joel J. P. C. Rodrigues and Lei Wan "Sleep Scheduling for Geographic Routing in Duty-Cycled Mobile Sensor Networks", IEEE, 2014, Pp 6346-6355.

[7] Hongseok Yoo, Moonjoo Shim and Dongkyun Kim "Dynamic Duty-Cycle Scheduling Schemes for Energy-Harvesting Wireless Sensor Networks", IEEE, 2012, Pp 202-204.

[8] Daibo Liu, Mengshu Hou, Zhichao Cao, Jiliang Wang, Yuan He and Yunhao Liu "Duplicate Detectable Opportunistic Forwarding in Duty-Cycled Wireless Sensor Networks", IEEE, 2016, Pp 662-673.

[9] Long Cheng, Canfeng Chen, JianMa and Lei "Contention-based geographic forwarding in asynchronous duty-cycled wireless sensor networks", International Journal of Communication Systems, 2011, Pp 1-19.

[10] Jinfang Jiang, Guangjie Han, Hui Guo, Lei Shu and Joel J.P.C Rodrigues "Geographic multipath routing based on geospatial division in duty-cycled underwater wireless sensor networks", Journal of Network and Computer Applications, 2016, Pp 4–13.

[11] Xianlong Jiao, Wei Lou, Junchao Ma, Jiannong Cao, Xiaodong Wang and Xingming Zhou "Minimum Latency Broadcast Scheduling in Duty-Cycled Multi-Hop Wireless Networks", IEEE, 2011, Pp 1-8.

[12] Mustapha Khiati and Djamel Djenouri "BOD-LEACH: broadcasting over duty-cycled radio using LEACH clustering for delay/power efficient dissimilation in wireless sensor networks", International Journal of Communication Systems, 2013, Pp 1-13.

[13] Xiaohua Xu, Jiannong Cao and Peng-Jun Wan "Fast Group Communication Scheduling in Duty-Cycled Multihop Wireless Sensor Networks", Springer, 2012, Pp 197-205.

[14] Kai Han, Liu Xiang, Jun Luo, Mingjun Xiao and Liusheng Huang "Energy-Efficient Reliable Data Dissemination in Duty-Cycled Wireless Sensor Networks", ACM, 2013, Pp 1-5.

[15] Zhong Shen, Hai Jiang and Zhongjiang Yan "Fast Data Collection in Linear Duty-Cycled Wireless Sensor Networks", IEEE, 2013, Pp 1-8..