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Improving LEACH Protocol in Wireless Sensor Networks

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ABSTRACT

With the growing utilization of Wireless Sensor Networks (WSN) in more and more areas, data transfer security becomes a important issue in research area. The secret key cryptography is not capable to offer security in WSN provided the nature of deployment area in the most applications *This paper introduces a new version of LEACH protocol known as VLEACH which targets to decrease energy consumption throughout the wireless network. We measure both LEACH and V-LEACH by extensive simulations employing OMNET++ simulator which indicates that VLEACH performs better as compared to LEACH protocol*.

Keywords

Broadcasting, LEACH protocol, Clustering, V-LEACH

I. INTRODUCTION

Wireless sensor network (WSN)[2,3] composed of hundreds and even thousands of small tiny devices known as sensor nodes distributed independently to monitor physical or environmental factors i.e. sound, temperature, pressure, vibration and motion at various locations. Energy plays a significant role in WSN because nodes are battery operated. Accordingly several protocols have been suggested for minimizing the energy consumption of these nodes.

Every node in a sensor network is basically fitted with a radio transceiver, one or more sensors or other wireless communications device, a small microcontroller, and an energy source, however in most WSN applications the energy source is a battery [6], energy plays a significant part in WSN, and maintaining the consumed energy of every node is a significant objective that must be taken when formulating a routing protocol for WSN.

Several routing protocols have been suggested in the literature i.e. LEACH[4,6],PAMAS[12].

Leach is taken as the most famous routing protocol that utilize cluster based routing for decreasing the energy consumption; in this paper we introduce an enhancement on the Leach Protocol that further improve the Power consumption, simulation results shows that our protocol performs better as compared to Leach protocol with respect to overall throughput and energy consumption.

II. MOTIVATION

In a sensor particle a small amount of resources are remained for security to be enforced. This is not sufficient to even keep the variables for asymmetric public key based cryptographic algorithms i.e. RSA and Diffie-Hellman. Therefore public key based systems are not suitable for sensor networks. Due to the resource constraints another solution is to utilize global keys. This is viable but a global key based system does not offer the required level of security. In opposite, complete pair-wise keying among nodes offers the best possible security, but it is not suitable for sensor network because of the resource restrictions [5].

The easiest mechanism of key distribution is to preload a single network-wide key into all nodes before enforcement [14]. Only one single key is saved in the nodes' memory and once enforced in the network, there is no requirement for a node to perform key exchange or key discovery however all the nodes in communication coverage area can transfer messages employing the key which they already share. On the other side, this strategy suffers a serious disadvantage that adjustment of a single node would lead compromise of the whole network by the shared key. Hence it fails in offering the basic secure need of a sensor network by building it easy for an antagonist attempting to attack [8].

An alternative key distribution strategy is fully pair-wise keys strategy, such as each node in the sensor network shares a different key with each other node in the network. The major problem with this pair-wise key strategy is its poor scalability. The no. of keys that must be saved in every node is proportional to the total no. of network nodes. However sensor nodes are resource-restrained, this brings important overhead which restricts the mechanism's availability except for it can only be efficiently utilized in smaller networks.

In sensor networks, we can employ a authorized, protected station as an arbiter to offer connection keys to sensor nodes. The sensor nodes manifest themselves to the base station, after which the base station produces a connection key and forwards it to both parties in a secure manner. An example of this type of protocol is SNEP, which is part of the SPINS security infrastructure [6] [7]. Since, this type of mechanisms suffers high energy consumption, which makes it available in most sensor network applications.

The introduced work is about to employ some security methods in LEACH-C protocol to offer a full proof security by employing more rounds of transmission to BS and less energy. For this, various choices are introduced to enhance the complete security scenario and consume less energy. At last, introduced methods are defined and these are compared for energy consumption.

Broadcasting: Broadcasting is the mechanism in which a source node forwards a message to all other network nodes. Figure.1 indicates the categorization of broadcasting techniques. One of these techniques is clustering which is utilized by LEACH protocol, and in which we are interested in.

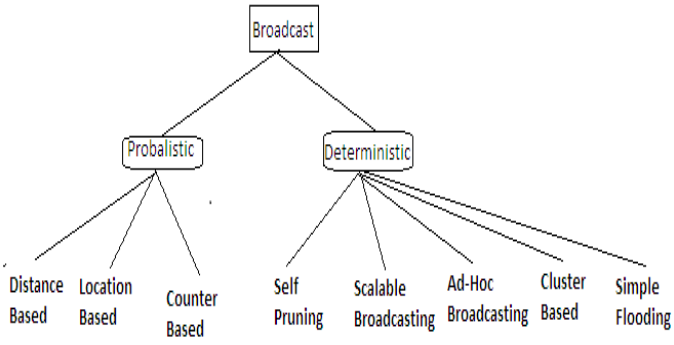

Fig. 1: Broadcasting

III. CLUSTER-BASED ROUTING IN WSN

The basic aim on any routing protocol is to build the network efficient and useful. A cluster based routing protocol groups sensor nodes where every group of nodes has a gateway or a CH [5,8]. Sensed data is forwarded to the CH instead of forward it to the BS, CH performs some aggregation activity on data it obtains then forward it to the BS where these data is required.

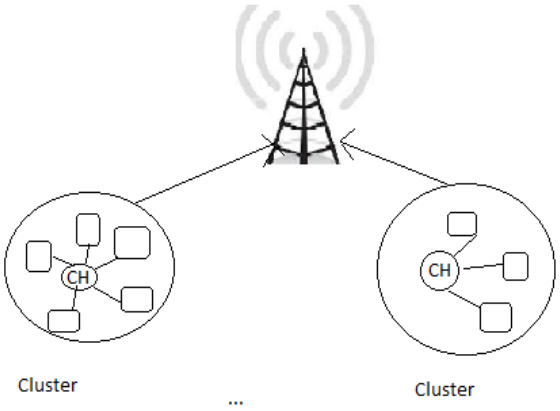

Figure 2: Cluster-Based Routing In WSN

A no. of routing protocols have been suggested for WSN [2,3,4]. Since, some of them are cluster based. Two of the most famous hierarchical protocols are PAMAS, LEACH and PEGASIS. Both of these indicate important decrement in the total network energy over other non-clustering protocol. Hierarchical routing protocols planned to decrease energy consumption by localizing communication in the cluster and combine data to decrease transmissions to the BS.

IV. LEACH PROTOCOL

Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical cluster-based routing protocol for WSN which divides the nodes into clusters, in every cluster a dedicated node with extra privileges known as Cluster Head (CH) is responsible for manipulating and creating a TDMA (Time division multiple access) schedule and forward combined data from nodes to the BS where these data is required utilizing CDMA (Code division multiple access). Left nodes are cluster members.

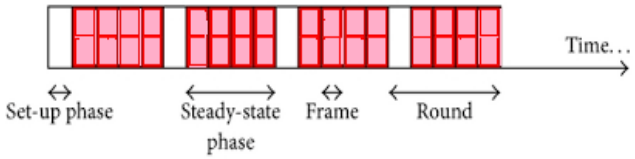

Fig.3: LEACH protocol phases

This protocol is classified into rounds; every round composed of two phases;

Set-up Phase

(1) Advertisement Phase
(2) Cluster Set-up Phase

Steady Phase

(1) Schedule Creation
(2) Data Transmission

***A. Setup Phase*:** Every node selects independent of other nodes if it will become a CH or not. This selection takes into consideration when the node behaved as a CH for the last time. In the advertisement phase, the CHs inform their neighboring node with an advertisement packet that they become CHs. Non-CH nodes take the advertisement packet with the strongest obtained signal strength. In the next cluster setup phase, the member nodes inform the CH that they become a member to that cluster with "join packet" has their IDs utilizing CSMA. After the cluster-setup sub phase, the CH knows the no. of member nodes and their IDs. Depending on all messages obtained within the cluster, the CH produces a TDMA schedule, take a CSMA code in a random way, and forward the TDMA table to cluster members. After that steady-state phase starts.

B. Steady-state phase: Data transmission starts; Nodes forward their data during their assigned TDMA slot to the CH. This transmission utilizes a minimum amount of energy (selected depending on the obtained strength of the CH advertisement). The radio of every non-CH node can be turned off until the nodes assigned TDMA slot, hence reducing energy dissipation in these nodes.

When entire data has been obtained, the CH combines these data and forwards it to the BS.

LEACH is capable to perform local combination of data in every cluster to decrease the amount of data that transmitted to the BS.

Though LEACH protocol performs in a good way, it suffers from several limitations such as;

- CH selection is in random way, that does not take into consideration energy consumption.
- It can't deal with a large region.
- CHs are not distributed uniformly; where CHs can be positioned at the cluster edges.

However LEACH has several limitations, various research have been performed to build this protocol performs better.

V. LITERATURE REVIEW

Kumar & Pal. 2013:- The scope of this research paper is the protocol aided LEACH (A-LEACH) which obtains uniform and decreased distribution of dissipated energy by distinguishing the tasks of data aggregation and routing. It presents the idea of helper nodes which guide cluster heads for multi-hop routing. A novel algorithm has been developed to provide energy effective multi-hop route establishment for helper nodes to arrive base station. The suggested protocol increases the network lifetime, reduces total energy dissipation in the network and distributes dissipation among sensor nodes, cluster heads and helper nodes vis-à-vis LEACH. This is supported by results of simulation. Helper nodes in assisted LEACH (A-LEACH) protocol has enhanced the network lifetime by distributing the reduced energy dissipation across the nodes. Simulation results and theoretical analysis ensure this.

Aslam, M., et al. 2012:- The main stress of his study is how to explore routing protocols work for increasing the life time, and how quality of routing protocol is enhanced for WSN. In hierarchical routing protocols entire network is classified into several clusters. One node in every cluster plays leading part. The only node is the cluster node that can communicate to base station in clustering routing protocols. This importantly decreases the routing overhead of normal nodes because normal nodes have to transmit to cluster-head only.Significant research work has been done in these diffrent clustering routing protocols in order to increase the lifetime and data delivery features.

S.Ahmed,M., et al. 2011:-The main motive of this research paper is to introduced a clustering algorithm for sensor networks ,called Low Energy Adaptive Clustering) Hierarchy(LEACH). LEACH forms clusters by using distributed algorithm,where nodes makes autonomous decisions without any centralized control. IMODLEACH protocol which is an extension to the MODLEACH protocol. Simulation resuls indicate that iMODLEACH in terms of network Life-time and packets transferred to basestation; that can be further utilized in other clustering routing protocols for better eficiency.

VI. TYPES OF LEACH PROTOCOLS

1.E-LEACH protocol:

Energy-LEACH protocol enhances the CH selection mechanism. It builds residual energy of node as the significant metric which selects whether the nodes turn into CH or not after the first round [9]. Similar to LEACH protocol, E-LEACH is classified into rounds, in the first round, each node has the same possibility to turn into CH, that mean nodes are chosen as CHs in a random way, in the next rounds, the residual energy of every node is different after one round communication and taken into consideration for choosing the CHs. That mean nodes have more energy will become a CHs instead of nodes with less energy.

2. TL-LEACH: In LEACH protocol, the CH gathers and combines data from sensors in its own cluster and directly forwards the information to the BS. CH might be positioned farther from the BS, so it utilizes most of its energy for transmitting and because it is always on it will die faster as compared to other nodes. A novel version of LEACH known as Two-level Leach was suggested. In this protocol; CH gathers data from other cluster members as real LEACH, but instead of transfer data to the BS directly, it utilizes one of the CHs that stays between CH and the BS as a relay station [7].

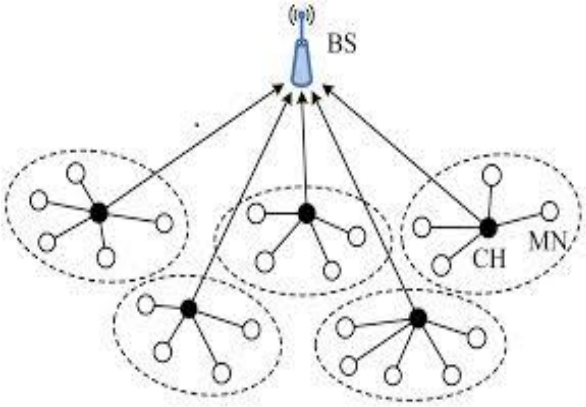

Fig. 4: TL-LEACH

3. M-LEACH protocol: In LEACH, Every CH directly communicates with Base Station irrespective the distance between BS and CH. It will take lot of its energy if the distance is greater. On the other side, Multi hop-LEACH protocol chooses optimum path between the BS and CH through other CHs and utilize these CHs as a relay station to transmit data over through them [8]. First, multi-hop communication is followed among CHs. Then, consequent to the chosen optimum route, these CHs transmit data to the corresponding CH which is closest to BS. At last, this CH forwards data to BS. M-LEACH protocol performs almost the same as LEACH protocol, only builds communication mode from single hop to multi-hop between BS and CHs.

4. LEACH-C protocol: LEACH provides no assurance about the placement and/or no. of cluster heads. In [13], an improvement over the LEACH protocol was introduced. The protocol, known as LEACH-C, utilizes a centralized clustering algorithm and the same steady-state phase as LEACH. LEACH-C protocol can generate better performance by distributing the cluster heads over the network. At the time of set-up phase of LEACH-C, every node forwards information about its current position (possibly determined utilizing GPS) and residual energy level to the sink. In summation to finding good clusters, the sink requires to assure that the energy load is evenly dispersed among all the nodes. To do this, sink calculates the average node energy, and computes which nodes have energy lower than this average. Once the cluster heads and related clusters are determined, the sink forwards a message that achieves the cluster head ID for every node. If a cluster head ID same as its own ID, the node is a cluster head; else the node determines its TDMA slot for data transmission and goes sleep until its time to transmit data. The steady-state phase of LEACH-C is same as that of the LEACH protocol.

5. V-LEACH: In our novel version of LEACH protocol, the cluster consists; CH (responsible only for forwarding data that is obtained from the cluster members to the Base Station), vice-CH (the node that will become a cluster CH in situation of CH dies), cluster nodes (collecting data from environment and forward it to the CH). In the real leach, the

CH is always on obtaining data from cluster members, combine these data and then forward it to the Base station that might be positioned farther from it. The CH will die faster as compared to the other nodes in the cluster due to its operation of obtaining, forwarding and overhearing. When the CH die, the cluster will become waste because the data collected by cluster nodes will never arrive the base station.
In our proposed protocol, along with having a CH in the cluster, there is a vice-CH that takes the CH role when the CH dies because the reasons we provided above.

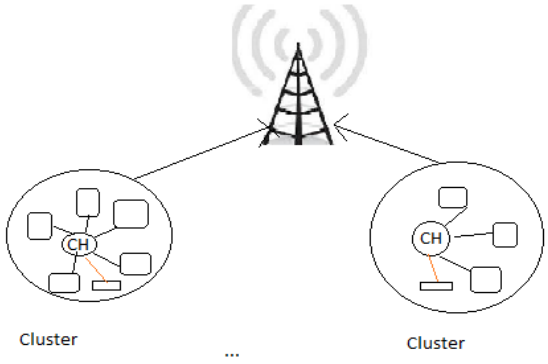

Fig. 5: VLEACH

By doing this, cluster nodes data will always arrive the Base Station; no requirement to elect a new CH every time the CH dies. This will extend the total lifetime of network.

VII. SIMULATION AND RESULT

OMNET++ is employed as a simulation platform. OMNET++ is an object-oriented Simulator discrete event network modeler, it has been formulated by András Varga [10]. In the Table.1 its Summaries various parameters employed in the simulation experiments**.** From the results of simulation that shown in figure 6 and 7, we can draw a no. of conclusions. The first: no. of messages generated by the V-LEACH is less as compared to the messages generated by the real LEACH and shows large throughput. The second: if messages generated by the novel version are less that implies the network energy left utilizing V-LEACH is more as compared to the left network energy utilizing the real LEACH.

Table 1: Various Simulation Parameters

Parameter	Value
Simulation time	3600 sec
Number of node	50, 100, 150 nodes
Topology size	1000 x 1000 *m*
Number of trials	20 trial
CH probability	0.2, 0.5, 0.1
Nodes distribution	Nodes are randomly distributed
Initial node power	5 Joule
BS position	Located at 2000 x 950

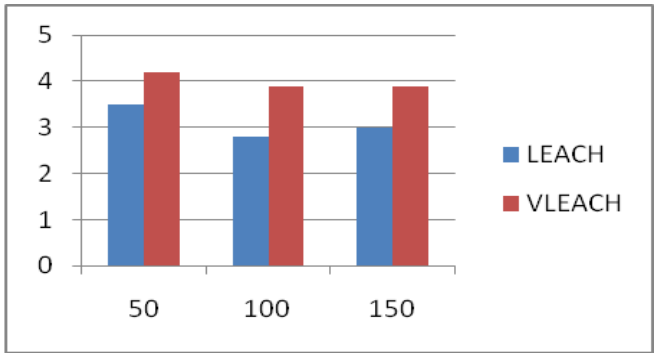

Figure 6: Network Load at various No. of nodes

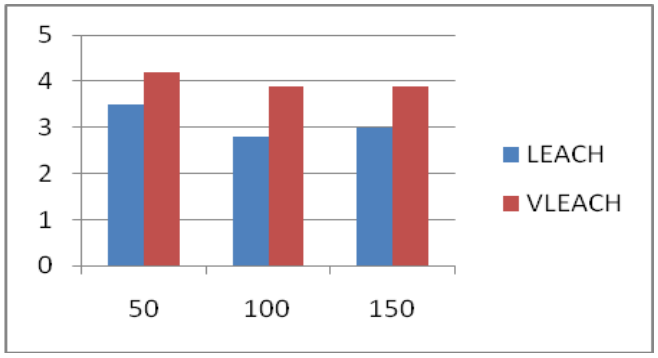

Figure 7: Throughputs at various no. of nodes.

VIII. CONCLUSION

In this research paper we have taken a famous protocol for WSN known as LEAH protocol which is the first and the most significant protocol in WSN which utilizes cluster based broadcasting method.
Followed by a survey of LEACH protocol implementations, then we introduced a novel version of LEACH protocol known as V-LEACH protocol.
From the results of simulation, we can draw a no. of conclusions. The first: no. of messages generated by the V-LEACH is less as compared to the messages generated by the real LEACH. The second: if messages generated by the novel version are less that implies the network energy left utilizing V-LEACH is more as compared to the left network energy utilizing the real LEACH. We prove that in table1.That mean the novel version of LEACH performs better as compared to the real version of LEACH protocol.

REFERENCES

[1] Stephan Olariu, "Information assurance in wireless sensor networks", Sensor network research group, Old Dominion University, Wireless Communication and Mobile Computing, Vol. 4,No 6,pp.623-637,2009.

[2] Harpreet Singh, Gurpreet Singh Josan, "Performance Analysis of AODV & DSR Routing Protocols in Wireless Sensor Networks", International Journal of Engineering ,Vol. 2, Issue 5,pp,2212-2216, September- October 2012.

[3] Xuanxia Yao, XueFeng Zheng, "A Secure Routing Scheme for Static Wireless Sensor Networks", IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application, Vol.2, pp.776-780, 2008

[4] Rayala Upendar Rao, "Secure Routing in Cluster based Wireless Sensor Networks using Symmetric Cryptography with Session Keys", International Journal of Computer Applications, Vol. 55, Issue. 7, pp.48-52, October 2012

[5] Bhoopathy, V. and R.M.S. Parvathi, "Securing Node Capture Attacks for Hierarchical Data Aggregation in Wireless Sensor Networks", International Journal of Engineering Research and Applications (IJERA), Vol. 2, Issue 2, pp.466-474,Mar-Apr 2012.

[6] K.S.Arikumar, K.Thirumoorthy, "Improved User Authentication in Wireless Sensor Networks", 2011 IEEE.

[7] Wassim Drira," A Hybrid Authentication and Key Establishment Scheme for WBAN", IEEE 11th International Conference on Trust, Security and Privacy in Computing and Communications, Vol. 2, No.3, pp.78-83, 2012

[8] Asha Rani Mishra, "Elliptic Curve Cryptography (ECC) for Security in wireless Sensor Network," International Journal of Engineering Research & Technology (IJERT) ,Vol. 1 Issue 3, pp. 2-3,May-2012.

[9] Donnie H. Kim, "Exploring Symmetric Cryptography for Secure Network Reprogramming", International conference on Information, Networking and Automation(ICINA),Kunming, IEEE, pp. 215-218, 2010.

[10] Shohreh Ahvar1, Mehdi Mahdavi, " EEQR: An Energy Efficient Query-Based Routing Protocol for Wireless Sensor Networks", Journal of Advances in Computer Research ,Vol. 2, No. 3, pp. 25-38, August 2011.

[11] Heissenbütte lM., T. Braun, M. Wälchli, and T. Bernoulli, "Optimized stateless broadcasting in wireless multi-hop networks," in proceeding of 4th IEEE international conference on Infocom Barcelona,2006,pp. 234-250.

[12] Sommer, C.; Dietrich, I.; Dressler, F. "Realistic Simulation of Network Protocols in WSN Scenarios" in Proceedings of International Journal of Ad Hoc and Ubiquitous Computing, Vol. 3, 2008, pp. 217-223.

[13] TsengY.C., Y.S. Chen, and J.P. Sheu, "The broadcast storm problem in a Wireless Sensor Networks, " In Proceeding of the 5th ACM/IEEE International Conference on Mobile Computing and Networking, NY, USA,1999, pp. 51-162.

[14] KorkmazG., E. Ekici, F. Ozgüner, and U. Ozgüner, "Urban multi-hop broadcast protocolforWireless Sensor Networks," In Proceeding of the 1st ACM International Workshop on Ad Hoc Networks, NY, USA, 2004,pp. 76-85.

[15] Rajive Bagrodia, Richard Meyer, Mineo Takai, Yu an Chen, Xiang Zeng, Jay Martin, andHa Yoon Song. "A parallel simulation environment for complex systems"in Proceedings of the 1st ACM international workshop on ad hoc networks; 2004; Pages: 66 – 75.

[16] v Brian D. Noble, Jungkeun Yoon ,Mingyan Liu, Minkyong Kim, "Building realisticmobility models in Wireless Sensor Networks", in Proceeding of the ACM International Conference On Mobile Systems, Applications And Services, pp. 177-190, 2006.

[17] Fan Li and Yu Wang; " Survey of Routing in Wireless Sensor Networks",in Proceedings ofIEEE Wireless Sensor Networks Technology Magazine, Volume 2, Issue 2, June 2007; pp. 12-22.

[18] Jahanzeb Farooq, Bilal Rauf "Implementation and Evaluation of IEEE 802.11e WirelessLAN in GloMoSim" In Proceeding of the 1st ACM International Workshop on Ad Hoc Networks, NY, USA, 2004,pp. 76-85.

[19] Yue Liu, Jun Bi, Ju Yang; "Research onWireless Sensor Networks"in Proceedings of Chinese Control and Decision Conference (CCDC), 2009, pp.4430 – 4435

[20] Abedi, O.; Berangi, R.; Azgomi, M.A., "Improving Route Stability and Overhead on AODV Routing Protocol and Make it Usable forWireless Sensor Networks," in Proceedings of 29th IEEE International Conference onWireless Sensor Networks,June 2009, pp.464,467.

[21] Chowdhury, S.I.; Won-Il Lee; Youn-Sang Choi; Guen-Young Kee; Jae-Young Pyun, "Performance evaluation of reactive routing protocols inWireless Sensor Networks," in proceeding of Communications (APCC), 2011 17th Asia-Pacific Conference onad hoc networks ,2011, pp.559,564.

[22] Sun Xi; Xia-Miao Li, "Study of the Feasibility of Wireless Sensor Networks and its Routing Protocols," in proceeding of Wireless Communications, Networking and Mobile Computing, 2008. 4th International Conference on ad hoc networks, 2008, pp.1-4.

[23] Vinod Namboodiri, Manish Agarwal, Lixin Gao; "A Study on the Feasibility of Mobile Gateways for Wireless Sensor Networks", in proceeding of Wireless Communications Networking and Mobile Computing 6th International Conference on 2010,Sept. 2010, pp.1,4, 23-25.

[24] Siva D., Abu B. Sesay, and Witold A. Krzymie´n, "A Design on Routing Protocol in Sensor Networks Based on Clustering Optimization" In Proceedings of 2nd International Conference on Future Computer and Communication,2010, pp 473-477.

[25] C. Y. Wan, S. B. Eisenman, and A. T. Campbell,, "CODA: Congestion Detection and Avoidance in Sensor Networks," In Proceedings of FirstACM Conference on Embedded Networked Sensor Systems,2003,pp.266-279.

[26] R.U.Anitha, P. Kamalakkannan ,"Enhanced Cluster Based Routing Protocol for MobileNodes in Wireless Sensor Network" In Proceedings of 2013 International Conference onPattern Recognition, Informatics and Mobile Engineering (PRIME), 2006,PP 187-193.

[27] Samera. B. Awwad, cheekyunng and Nor K. Noordin "Cluster Based Routing (CBR) Protocol with Adaptive Scheduling for Mobility and Energy Awareness in Wireless Sensor Network," In Proceedings of Proceedings of the Asia Pacific Advanced Network,2009, pp 34-46.

[28] R. Balasubramaniyan , Dr. M. Chandrasekaran "A New Fuzzy Based Clustering algorithm for Wireless Mobile Ad-Hoc Sensor Networks "In Proceedings of 2013 International Conference on Computer Communication and Informatics,2013, pp 31-37