International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Survey on Energy Efficient Routing Protocol in Wireless Sensor Network

Poonam Kudale[1], M. D. Ingle[2]

[1]ME Computer (Engineering), Jayawantrao Sawant College of Engineering, Hadapsar, Pune-28, Savitribai Phule Pune University, Pune, India

[2]Professor, Computer Engineering, Jayawantrao Sawant College of Engineering, Hadapsar Pune-28, Savitribai Phule Pune University, Pune, India

Abstract: ***Wireless Sensor Networks have an expanded length of applications but there are hurdles with many asserting issues and complications that should be addressed. The power exhaustion of the nodes and the broadening of the network life span are the basic challenges. As the sensor nodes are devices with limited energy, limited bandwidth and limited computing power, so the top interest is always about how to minimize the energy depletion to extend its lifetime and thus the lifespan of the WSN. In the past few years WSNs has achieved an appreciable amount of consideration from both the research associations and the real users. The experimenter also proposed various energy optimization routing protocols to acquire the desired network operations. In this paper there is an endeavor to present a wide analogy of the routing protocols in WSNs focusing on the hierarchical or clustering based routing protocols. Moreover, deriving the pros and cons of each protocol, giving a comparison among them on the basis of parameters like scalability, mobility, power usage, robustness etc. to make it comprehensible and easy to select the most suitable one as per the requirement of the network.***

Keywords: Wireless Sensor Networks, Routing Protocols, Clustering, Energy Efficiency

1. Introduction

Wireless Sensor Networks (WSNs) imported an effective divergence in bringing betterment in technologies and also contributing contingency for impressive management of resources in critical circumstances. WSNs are fundamentally the set of wireless nodes with bounded energy capabilities, are placed randomly over an unstable surroundings, may be mobile or stationary, for monitoring physical conditions such as humidity, temperature, health monitoring, vibrations, seismic events etc. Choosing a routing scenario is the base controversy for collecting and passing the packets of important message to the stated station. So the routing scenario should assure the lowest power utilization resulting in expanding the network's lifespan.

The WSNs is used in the variation of day to day life activities. Some example includes for monitoring like in Defense to detect enemy intrusion or monitoring the air pollution or to be used for fire detection to control when a fire has started. In addition, a decisive area of use is the healthcare sector. Furthermore, the use of WSNs in agronomy may assets the industry, frees the farmer from the preservation and wiring in a troublesome environment.

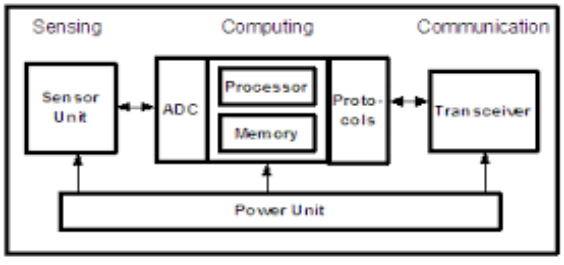

Figure 1: Components of Sensor node

As shown in fig. 1, a sensor node is generally small bounded power devices that subsist of four elemental components. First is the sensing component for data obtainment, then the control component for the local data processing and memory manipulations, then a communication component for transportation and reception of data and lastly a source of energy that provides the prescribed energy to carry out the desired work. This energy source basically consists of a battery with bounded energy so if a critical node stop functioning then it's a large and deliberate protocol breakdown. As the sensor nodes are deployed randomly in adverse environment, it is not possible to recharge the sensor nodes with the decrease in its power. So to meet the scenario requisite the sensor nodes should have sufficient and extended life time. Energy is a deliberate asset and should be used very anxiously. It is clear that the energy is a basic controversy for the systems grounded on WSNs. So it is needed to focus on the issue of prolonging the lifetime of the node.

The dispersed protocols can be a great explication in administrating the failures more effectively. Clustering based routing protocols which are invented for the power adaptability of a network are proficient of data aggregation. Data aggregation is a technique in which data is been gathered from multiple sensors at intermediate nodes and transmits the accumulated data to the base station. Data aggregation includes collection of critical data and makes data available to the base station in an energy profitable manner with less latency. Basically data aggregation protocols can be classified into two categories based on the topology. They are tree based data aggregation protocols and cluster based data aggregation protocols. Group of nodes configures a cluster. The classification of these nodes into clusters is called clustering. Postponement can be simply diminished because within a cluster the localized algorithms can operate without waiting for the control messages. So as distinguished with the centralized algorithms the localized

algorithms can accomplish extra stability and throughput. In clustering certain nodes are elected as Cluster Heads (CHs) which had to utilize extra energy than rest of the nodes for a particular time span. The data from the sensor nodes is directed to CHs and then these CHs are culpable to handover the data to the base station (BS) which is placed at another location. Fig.2 shows the concept of Data aggregation in cluster based topology.

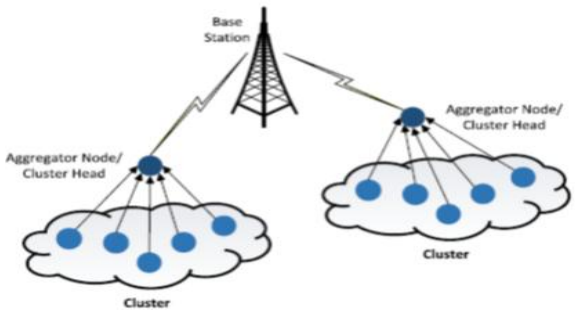

Figure 2: Clustering based data aggregation

WSNs show some distinct attributes such as ease of setting up nodes densely, unreliability of sensor nodes, relentless power utilization and storage restraint which introduces various threats in the construction of WSNs. All such issues need to be decreased or even overwhelmed by designing power profitable protocols based on the applications.

2. Hierarchical Routing in WSN

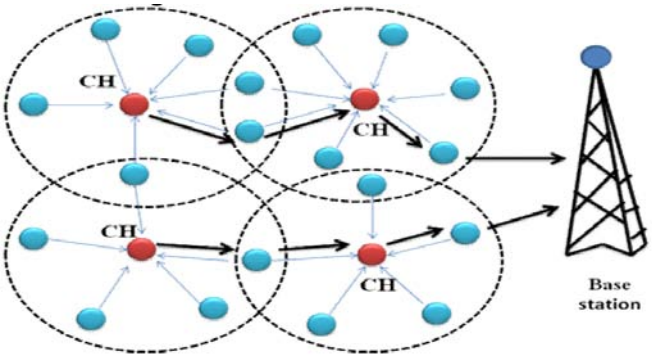

Figure 3: Hierarchical Routing in WSN

All the data which is sensed by the sensor nodes is sent to the base station via CH. The CHs are managed by the BS which is a root in the hierarchy as shown in the figure. Inter-cluster and intra-cluster communication would be used to decrease the collision among groups and group members by MAC protocols. Unlike conventional transference, the volume of bandwidth usage and distance transference in hierarchical routing is decreased notably; this saves lot of energy of the nodes.

3. Related Work

1) E2R2: Energy-Efficient and Reliable Routing for Mobile Wireless Sensor Networks [1]

In this paper, authors have proposed a hierarchical and clustering based energy efficient routing protocol. In this, each group contains one cluster head (CH) node, two deputy CH nodes, and some normal sensor nodes. The regrouping time and energy requirements have been reduced by proposing the concept of CH panel. At the early stage of the protocol, the BS selects a set of possible CH nodes and creates the CH panel. Taking into account the reliability issue of the protocol, it gives best effort to assure a stated throughput level at the base station. Based on the structure of the network, the data transportation from the CH node to the BS is done either directly or in multihop manner. Furthermore, replacement paths are used for data transportation among a CH node and the base station. Proposed protocol assures the energy effectiveness, throughput, and enhanced lifespan of the nodes and thus the network.

2) LEACH: Low Energy Adaptive Clustering Hierarchy [2]

In LEACH protocol, all the sensor nodes communicate to cluster heads.

"LEACH" consists of two phases:
1) The Setup Phase: In this phase, the groups of sensor nodes are formed and then CH is selected. The functioning of CH is to accrue, cover, and forward the data to the base station. But issue is about deciding the CH among all the deployed sensor nodes. "Stochastic algorithm" is the option for the same, which decides the CH. But it will be applicable with a constraint that, if a sensor node will be CH, the coming time it will not be preferred in the "P- Round". It means that in the every iteration the probability to be selected as CH for each sensor node is 1/P. These proper iterations of the nodes in each round moves towards equitable power utilization by all the sensor nodes and hence will improve the lifespan of the network.

2) The Study State Phase: In the previous state, the sensor nodes and the CH have been formulated, but in the second phase of "LEACH" protocol, the data is communicated to the base station. Time span of this state is larger than the last state in order to reduce the overhead. Each sensor node in the network, communicates with the cluster head, and transport the data to it, after that CH will establish the agenda to transport the data of each sensor node to base station. Benefits of this technique are it surpasses traditional communication protocols, in terms of power depletion, ease of composition, and system lifespan/quality of the network. This protocol is most appropriate when there is a necessity for constant observing by the sensor network. A data may not be needed by user immediately.

Thus periodic data transportation is useless which may drain the bounded energy of the sensor nodes. After some specified time period a randomized rotation of the duty of the CH is conducted so that uniform energy dissipation in the sensor network is obtained.

3) Power-Efficient Gathering in Sensor Information

(PEGASIS) [3]

The basic idea of chain based protocol called PEGASIS is to increase the life of the network. This can be achieved by forming the chain of the nodes deployed in the network, from sending node to the Base Station. To discover the convenient acquaintance node in PEGASIS, each sensor node uses the signal strength to calculate the range to all acquaintance nodes and then accommodate the signal strength so that only one sensor node can listen. The chain in PEGASIS will subsist of those sensor nodes that are near to each other and construct a route to the base station. The chain is formed in a greedy manner.

PEGASIS achieves two main goals. First, expand the lifespan of each sensor node by using cooperative technique and as an outcome the network lifespan will be increased. Second, allow only regional coordination among sensor nodes that are close to each other so that the bandwidth absorbed in conversation is reduced.

4) Threshold-sensitive Energy Efficient Protocol (TEEN) [4]

In TEEN, a sensor node captures the channel constantly, but the data transportation is conducted less intermittently. A CH transmits a hard threshold value (threshold value of the sensed attribute) and soft threshold value (small alteration in the reading of the sensed attribute that informs the sensor node to shift on its transmitter and send) to its members. Hence the hard threshold attempts to decrease the number of transmissions by granting the sensor nodes to send only when the captured attribute is in the area of interest. The soft threshold additionally decreases the number of transmissions that might have else way appeared when there is small or no change in the captured attribute. A little value of the soft threshold produces a more precise picture of the network, at the cost of growth in energy utilization. Thus, the user can manage the adjustment between power adaptability and data truthfulness. When CH are to be newly selected, fresh values for the above attributes are announced. The core disadvantage of this approach is that, if the threshold values are not obtained, the sensor nodes will not connect, and the user will not receive any data from the WSN.

The node monitors their surrounding constantly. The 1st time a specification from the attribute set grasp its hard threshold value, the node shifts its transmitter on and transmits the captured data. The captured value is saved in the local variable, called as Sensed Value (SV). The sensor nodes will send data in the present group period only when the stated constraints are true: (1) The present value of the sensed attribute is larger than the hard threshold value (2) The present value of the sensed attribute contrast from SV by an quantity equal to or larger than the soft threshold. Valuable features of TEEN consist of its appropriateness for time critical sensing applications. Also, since data transportation utilizes more energy than data capturing, so the energy utilization in this technique is low than the proactive networks. The soft threshold value can be different. At every cluster formation time, the new specifications are announced and so, the user can modify them as per necessity.

5) Adaptive Threshold-sensitive Energy Efficient Protocol (APTEEN) [5]

APTEEN which is the advancement over TEEN is a hybrid protocol that modifies the threshold values utilized in the TEEN protocol as per the user's necessity and the type of the application. In APTEEN, the CH announces the stated parameters-

1) Attributes (A): this is a set of physical specification.
2) Thresholds: Hard Threshold (HT) and the Soft Threshold (ST).
3) Schedule: this is a TDMA schedule, allocating a time to each sensor node.
4) Count Time (CT): Highest time slot between two following reports transmitted by a sensor node.

The sensor node monitors the surrounding constantly, and only those nodes which capture a data value at or above the hard threshold transmit. Once a sensor node captures a value above Hard Threshold, it sends data only when the values of that attribute alter by an amount same as or larger than the ST. If a sensor node does not transmit data for a time slot equivalent to the count time, it is enforced to capture and resend the data. A TDMA schedule is used and each sensor node in the group is allocated a transportation slot. Thus, APTEEN uses a modified TDMA schedule to design the hybrid network. The core characteristics of the APTEEN technique consists the following things. It integrates both proactive and reactive guidelines. It gives elasticity by granting the user to fix the count-time interval (CT), and the threshold values for the power utilization can be managed by altering the count time as well as the threshold values. The core disadvantage of the scheme is the extra complexity needed to design the threshold functions and the count time.

6) Hybrid Energy Efficient Distributed clustering Protocol (HEED) protocol [6]

Hybrid Energy Efficient Distributed clustering Protocol (HEED) is another energy efficient protocol which focuses on prolonging the lifetime of the sensor nodes and thus the lifetime of the network. It extends the elementary or the basic idea of LEACH protocol by using enduring energy as first parameter and network structure characteristics such as sensor node degree, distances to acquaintance are only used as second metric to demolish the tie among the aspirant CH, as a parameter for cluster choice to accomplish energy balancing. The process of grouping of nodes is divided into a number of rounds, and in each round sensor nodes that are not considered in any group, CH doubles their possibility of becoming a cluster head. As these power profitable grouping protocols further allows each sensor node to possibly and individually choose its job in the clustered network. Furthermore they cannot assure best selected set of cluster heads.

Pros of HEED protocol are- 1) In a multi-hop manner, communication among CHs and BS provides more power conservation and scalability in oppose to the single-hop manner, i.e. large distance communication from CHs to the BS, as within the LEACH protocol. 2) It is a dispersed

clustering technique that is advantageous with the use of the two important metrics for CH election.

Cons of HEED protocol are- 1) Same as LEACH, the grouping of nodes in each iteration includes significant burden in the network. This burden causes notable power dissipation which results in reducing the network lifespan. 2) HEED endures from a consecutive overhead since it requires various rounds to form the groups of clusters. Hence at iteration, large amount of packets are broadcasted. 3) Some CHs, mainly close the BS, might die former because these CHs have large workload.

7) EECS: An energy efficient clustering scheme in wireless sensor networks [7]

In this paper [7], authors have proposed Energy Efficient Clustering Scheme (EECS) protocol. It is a new grouping / clustering scheme for timely data gathering applications for wireless sensor networks. It decides cluster heads (CH) with maximum remaining power via local radio communication. During the CH-cluster head selection step, a stable number of candidate sensor nodes are selected and strive for the position of cluster heads as per the sensor node remaining energy/ power. The striving method is localized and with no repetition. The method also gives a close uniform dispersion of cluster heads. Furthermore in the group formation step, a distinct approach is proposed to manage the load between CHs-cluster heads. On the other side, it increases the importance of global knowledge about the distance ranges among the CHs cluster heads and the BS base station. In this, grouping is done by dynamic sizing on the basis of cluster distance from the base station. This pinpoints the issue that the clusters having a large distance to the Base Station need more power for sending the data as compared to nodes with a less distance, and gives less message burden and uniform dispersion of cluster heads as compared to LEACH.

8) An energy efficient routing scheme for mobile wireless sensor networks [8]

In this paper authors have introduced a power efficient clustering algorithm for mobile sensor network on the basis of the LEACH protocol. The introduced protocol extends the features of LEACH to support for mobile or dynamic location changing nodes and also decreases the utilization of the network resource. For providing mobility to the cluster members a scheme is used that is the combination of both LEACH-C and LEACH.

In the Setup step of M-LEACH, each node transmits its information such as locations, velocity and power level to Base Station. On the basis of received data, BS calculates the cluster-head and transmits the schedule to all sensor nodes. Based on the received schedule, each node decides its cluster head and schedule to transmit on its self time slot using DSSS spreading code to assure the minimal inter cluster interference. After getting data from sensor nodes, cluster head i.e. CH aggregates the data and transmits the aggregated data back to BS. M-LEACH allows non-cluster head nodes join to the nearest cluster head.

9) SPEED: A stateless protocol for real-time communication in sensor networks. [9]

In paper [9], authors have introduced SPEED protocol to give smooth end-to end deadline assurance for real-time packets in wireless sensor networks. It utilizes a geological forwarding technique such that each packet can be transmitted without requiring global structure/topology information. Hence, it can extend well to a big range sensor network. More necessarily, it guarantees a network wise speed of data packet deployment for real-time applications. To achieve this, each sensor node keeps information about neighbour node like distance and average delay to each neighbour. On the basis of such information, each sensor node estimates the packet progress speed of every neighbour sensor node and sends a packet towards a node whose progress speed is better than the given lower-bound speed SetSpeed. If node can detect a neighbour that can process a data packet with a higher speed than SetSpeed, SetSpeed can be assured network widely. But, if the packets to be transmitted are too heavy, it is not always probable. When a sensor node cannot detect any neighbour node having speed higher than SetSpeed, it approximately drops the data packets to regulate the workload. Hence there should be at least one neighbour node having speed higher than SetSpeed.

10) MMSPEED: Multipath multispeed protocol for QOS guarantee of reliability and timeliness in wireless sensor networks [10]

In this paper [10], authors have introduced a new packet delivery technique named MMSPEED for wireless sensor networks to give service discrimination and probabilistic QoS assures in the timeliness and reliability field. For the timeliness field, multiple network-wide speed options are provided so that different traffic types can demoniacally select the appropriate speed options for their data packets on the basis of their end-to-end deadlines. For the reliability field, probabilistic multipath forwarding technique is used to manage the number of packet delivery routes on the basis of necessary end-to-end reaching probability. These methods are constructed in a confined way with changing allowance to compensate for the inaccuracies of local decisions as packets progress towards their destinations. Since the proposed mechanisms work locally at each node without global network state information and end-to-end route arrangement, it can conserve seductive properties like scalability for big sensor networks, self adaptability to network dynamics, and appropriateness for urgent aperiodic and periodic packets. Simulation results show that MMSPEED can effectively help for the requirements of different traffic types with different combinations of reliability and timeliness requirements. As an outcome, MMSPEED can considerably increase the adequate capability of a sensor network in terms of number of flows meeting both reliability and timeliness requirements.

Table 1: Literature Survey

Sr. No.	*Title Of Paper*	*Author and Year*	*Technique Used*	*Advantage*	*Disadvantage*
1.	E2R2: Energy-Efficient and Reliable Routing for Mobile Wireless Sensor Networks [1]	Hiren Kumar Deva Sarma, RajibMall, Avijit Kar (2016)	Authors have proposed a protocol named E2R2, which is hierarchical and cluster based protocol. In this, each cluster contains one CH node, and the CH node is assisted by two DCH nodes, which are also called cluster management nodes to handle the energy efficiency, reliability and mobility of the nodes and BS.	Gives better energy efficiency, throughput, and prolonged lifetime as compared to existing techniques. Also handles the mobility of the sensor nodes and BS.	It only allows energy efficient and reliable routing, but it does not consider the issue of security of nodes.
2.	Energy-efficient communication protocol for wireless microsensor networks. [2]	W. Heinzelman, A. Chandrakasan, and H. Balakrishnan (2000)	LEACH selects the cluster head by random number generation. Cluster gets formed based on the nearest distance. LEACH uses one hop conversation. It emphatically manages the energy utilization in the WSN.	Low energy, ad-hoc, distributed protocol	It is not applicable to networks deployed in large regions and the dynamic clustering brings extra overhead.
3.	PEGASIS: power efficient gathering in sensor information systems [3]	S. Lindsey, C.S. Raghavendra (2002)	This technique is an improvement over LEACH. In this, each node communicates only with a close neighbour and takes turns transmitting to the base station.	The transmitting distance for most of the node is reduced	There is no consideration of the base station's location about the energy of nodes when one of the node is selected as the head node.
4.	TEEN: A routing protocol for enhanced efficiency in wireless sensor networks. [4]	A. Manjeshwar and D. P. Agarwal (2000)	This technique uses the terms called hard threshold, soft threshold. Based on these values the clusters are formed and the time of transmission is decided.	It works well in the conditions like sudden changes in the sensed attributes such as temperature.	A lot of energy consumption and overhead in case of large network.
5.	APTEEN: A hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks. [5]	A. Manjeshwar and D. P. Agarwal (2002)	It is an enhancement over TEEN. This technique makes use of Attributes, thresholds, count time and TDMA schedule for the clustering and transmission process.	Low energy consumption	Long delay, Mobility of nodes is not considered.
6.	HEED: A hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks. [6]	O. Younis and S. Fahmy (2010)	HEED protocol considers energy and network structure features such as sensor node degree, distances to acquaintance to form the clusters and to select the CH.	Low power levels of clusters endorse an increase in spatial reuse while high power levels of clusters are needed for inter-cluster communication. This imparts uniform CH distribution across the network and load balancing.	Tentative CHs that do not become final CHs leave some uncovered nodes. Based on implementation of HEED, these nodes are forced to become a CH and these forced CHs may not have any member associated with them or may be in range of other CHs. As a result, more CHs are generated than the expected number and this also responsible for unbalanced energy consumption in the network.
7.	EECS: An energy efficient clustering scheme in wireless sensor networks [7]	M. Ye, C. Li, F. Chen, and G. J.Wu (2007)	EECS protocol is a clustering scheme which decides CH with maximum energy. A stable number of candidate sensor nodes are selected and strive for the position of cluster heads on the basis of remaining energy.	Builds balancing point between intra-cluster energy consumption and inter-cluster communication load based on energy and distance.	Long-range transmissions directly from CHs to the BS may lead to huge energy consumption. Thus, it is not suitable for large-range networks

8.	An energy efficient routing scheme for mobile wireless sensor networks [8]	L. Tien Nguyen, X. Defago, R. Beuran, and Y. Shinoda (2008)	Authors have introduced a power efficient clustering algorithm for mobile sensor network on the basis of the LEACH protocol. For providing mobility to the cluster members a scheme is used that is the combination of both LEACH-C and LEACH.	This scheme can handle mobility of sensor nodes.	Though it handles mobility of sensor nodes, it does not consider mobility in the BS
9.	SPEED: A stateless protocol for real-time communication in sensor networks [9]	T. He, J. Stankovic, C. Lu, and T. Abdelzaher (2003)	SPEED protocol utilizes a geological forwarding technique. Each sensor node keeps data about neighbor node like distance and average. On the basis of such data, each sensor node estimates the packet progress speed of every neighbor node and sends a packet towards a node whose progress speed is better than the given lower-bound speed SetSpeed.	SetSpeed is uniformly guaranteed all over the network and thus we can predict if the end-to-end deadlines of packet can be met and every mechanism works in a localized way and, hence, SPEED is quite scalable.	The SPEED protocol provides only one network-wide speed, which is not suitable for differentiating various traffic with different deadlines. In addition, it is limited to provide any guarantee in the reliability domain.
10.	MMSPEED: Multipath multispeed protocol for QOS guarantee of reliability and timeliness in wireless sensor networks [10]	E. Felemban, C.-G. Lee, and E. Ekici (2006)	MMSPEED gives service discrimination and probabilistic QoS in the timeliness & reliability field. For timeliness, various speed options are provided for different traffic types. For reliability, probabilistic multipath forwarding technique is used to manage the number of packet delivery routes on the basis of necessary end-to-end reaching probability.	MMSPEED can considerably increase the adequate capability of a sensor network in terms of number of flows meeting both reliability and timeliness requirements.	Protocol considers static WSN only i.e. it does not consider the mobility of sensor nodes and BS.

4. Conclusion

WSNs have hugely extended in playing a key job for the data decisive selection and shipment. The power effectiveness is a very most necessary controversy for the networks mainly for WSNs which are explained by "bounded battery abilities". Due to complicatedness in WSNs operations, there is necessity of the power-efficient routing approach and protocols, which will encourage the network connectivity and transmission of data with less required energy.

In this paper spotlight is on the energy profitable hierarchical protocols that have been designed for WSNs. If a large network is considered, the flat protocols become "inconceivable" because of link and the processing burden. This is an issue and the hierarchical protocol struggle to solve it and as an outcome gives scalable, profitable and effective solutions. They divide the network into "clusters/groups" to effectively manage the energy utilization of sensor nodes and also perform "data aggregation and fusion" to mitigate the number of sent messages to the BS. The clusters/groups are organised based on the power backup of sensors and sensor's closeness to the CH. Hence, we can conclude that the hierarchical protocols are suitable for sensor networks with the huge load and expanded coverage area. So in order to construct a scheme that will increase the lifespan of the WSNs is required to reduce the energy utilization of the sensor nodes within the network.

Accordingly, the application of the suitable routing protocol will prolong the lifespan of the network and at the same time it will assure the network connectivity and profitable data or message shipment.

References

[1] Hiren Kumar Deva Sarma, Member, IEEE, RajibMall, Senior Member, IEEE, and Avijit Kar, "E2R2: Energy-Efficient and Reliable Routing for Mobile Wireless Sensor Networks," IEEE systems journal, vol. 10, no. 2, june 2016
[2] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient communication protocol for wireless microsensor networks," in Proc. 33rd Annu. HICSS, 2000, pp. 1–10.
[3] S. Lindsey, C.S. Raghavendra, "PEGASIS: power efficient gathering in sensor information systems", in: Proceedings of the IEEE Aerospace Conference, Big Sky, Montana, March 2002.
[4] A. Manjeshwar and D. P. Agarwal, "TEEN: A routing protocol for enhanced efficiency in wireless sensor networks," in Proc. 15th IPDPS Workshops, 2000, pp. 2009–2015.
[5] A. Manjeshwar and D. P. Agarwal, "APTEEN: A hybrid protocol for efficient routing and comprehensive

information retrieval in wireless sensor networks," in Proc. IPDPS, 2002.
[6] O. Younis and S. Fahmy, "HEED: A hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks," IEEE Trans. Mobile Comput., vol. 3, no. 4, pp. 366–379, Oct.–Dec. 2004.
[7] M. Ye, C. Li, F. Chen, and G. J.Wu, "EECS: An energy efficient clustering scheme in wireless sensor networks," *Int. J. Ad Hoc Sens. Netw.*, vol. 3, no. 2/3, pp. 99–119, 2007
[8] L. Tien Nguyen, X. Defago, R. Beuran, and Y. Shinoda, "An energy efficient routing scheme for mobile wireless sensor networks," in *Proc. IEEE ISWCS*, 2008, pp. 568–572.
[9] T. He, J. Stankovic, C. Lu, and T. Abdelzaher, "SPEED: A stateless protocol for real-time communication in sensor networks," in *Proc. IEEE Int. Conf. Distrib. Comput. Syst.*, pp. 46–55, 2003.
[10] E. Felemban, C.-G. Lee, and E. Ekici, "MMSPEED: Multipath multispeed protocol for QOS guarantee of reliability and timeliness in wireless sensor networks," IEEE Trans. Mobile Comput., vol. 5, no. 6, pp. 738–754, Jun. 2006.
[11] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," IEEE Commun. Mag., vol. 40, no. 8, pp. 102–114, Aug. 2002.
[12] A. A. Abbasi and M. Younis, "A survey on clustering algorithms for wireless sensor networks," Comput. Commun., vol. 30, no. 14/15, pp. 2826–2841, Oct. 2007.
[13] L. Tien Nguyen, X. Defago, R. Beuran, and Y. Shinoda, "An energy efficient routing scheme for mobile wireless sensor networks," in Proc. IEEE ISWCS, 2008, pp. 568–572.
[14] M. Handique, P. Rai, S. R. Biradar, and H. K. D. Sarma "Energy efficient hierarchical cluster based communication protocol for wireless sensor networks with base station mobility," in Proc. IEEE CODEC, Kolkata, India, pp. 214–221, 2006.

Author Profile

Ms. Poonam P. Kudale, is currently pursuing M.E (Computer) from Department of Computer Engineering, Jayawantrao Sawant College of Engineering, Pune, India. Savitribai Phule Pune University, Pune, Maharashtra, India – 411007. She received her B.E (Computer) Degree from Jayawantrao Sawant College of Engineering, Pune, India. Savitribai Phule Pune University, Pune, Maharashtra, Indi – 411007. Her area of interest is Wireless Sensor Network and Network Security.

Prof. M. D. Ingle, is currently pursuing Ph.D in WSN. He earned his M Tech (Computer) Degree from Dr. Babasaheb Ambedkar Technological University, Lonere, Dist. Raigad- 402103, Maharashtra, India. He earned his B.E (Computer) Degree from Govt college of Engineering, Aurangabad, Maharashtra, India. He is currently working as M.E coordinator and Asso. Prof. (Computer) at Department of Computer Engineering, Jayawantrao Sawant College of Engineering, Pune, India.