JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# A BRIEF REVIEW OF THE WIRELESS SENSOR NETWORK

**[1]Shivam Gupta, [2]Er.Abhishek Srivastava**
[1]M.Tech Student, [2]Assistant Professor
[1,2]Department of Electronics and Communication Engineering
[1,2]IET Dr.Ram Manohar Lohia Awadh University (Uttar Pradesh), India

**Abstract:** Wireless sensor Networks (WSNs) are networks with gadgets that can identify, interact, store, and convey remotely. Multiple sensing devices capable of measuring physical variations like temperature, brightness, humidity, and vibration are available for each network terminal. WSN development and implementation, on the other hand, is fraught with difficulties. The difficulties that arise when employing various routing algorithms, including geographic routing, energy-aware routing, delay-aware routing, QoS-aware routing, secure-aware routing, and hierarchical-aware routing, are discussed in this overview.

***Index Terms* – Data aggregation, Dynamic cluster head rotation, Heterogeneous system, Leach Protocol, WSN.**

## INTRODUCTION

The latest advances have made enormous advances in PC time and besides upgrading the use of computers in our step by step works out. Due to lower costs and a shorter lifespan of PCs, single-focus desktop computers with coordinated remote hubs have become increasingly popular in recent years. Due to their generous relevance in enhancing our lives, remote systems have recently received a lot of attention. The dispersed remote hubs in a remote hub field are depicted in Figure 1.2. The ABCDE- source can be used to direct the data in this example. Since the sinkhole is now connected to the Internet, it can provide information that can be easily distinguished between the action and the client. Far-off-center points in far-off frameworks can independently plan and take apart data distinguished in a joint effort inside the framework so they can cut tedious data seen inside a framework and give simply the data essential to the client. Besides, far-off frameworks can logically change their geography. After freely transmitting remote hubs in a remote hub field, these hubs become neighbors and begin communicating in various ways, typically through multi-bounce correspondences. These circumstances integrate periphery affirmation, perilous circumstances, regions related to prosperity, control of the sharp home, and altogether more. WSNs are used to identify and track tanks in a combat zone, faculty following in a building, measure the rate of activity on a course, screen for environmental toxins, and recognize rain and fire. Remote hubs contribute to the generation of power and are also used in the accumulation of sunlight-based energy for WSNs. In remote interchanges, customer hubs may send information via the internet to the static sink hub, such as in climate applications.


**Figure 1.1: Wireless Network Architecture**

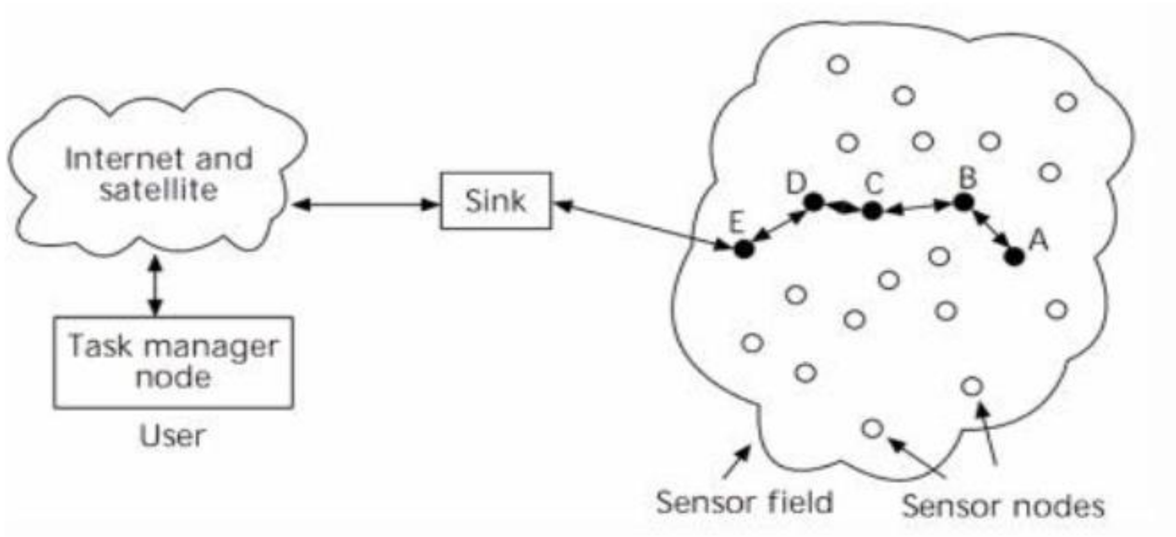


**Figure 1.2: Wireless nodes scattered in a wireless node field**

Imperativeness usage is an essential restriction of WSN which requires the researcher's aptitudes to get a course in lessening essentialness use by distant center points used as a piece of WSN. Analysts are focusing on identifying and overcoming the limitations of remote systems in the most recent research on WSN, such as limited energy resources, expanding energy use by region, the high cost of transmission, and limited handling capacities.

The majority of remote system topologies consist of numerous system hubs dispersed throughout a specific physical region. It is generally no plan or specific levels of leadership set up and thusly, distant frameworks are viewed as uniquely delegated frameworks. An arrangement of unrehearsed distant center points can work in a free mode, or it very well may be related to various frameworks, for instance, the greatest Web through a base station. To upgrade organized versatility and achieve imperativeness and useful coordination, the use of the portrayal structure for directing is a crucial figure of WSN. Along these central focuses, the batching plan has more central focuses, for instance, security of information transmission using while correspondence inside gatherings, diminishing overabundance of messages moving between center points in a framework, and developing close-by roads in bundles.

**Related Work :**

Georgios Smaragdakis et al. (2004) [2] investigate the energy impact of heterogeneous nodes in hierarchically clustered wireless sensor networks. Some of the nodes in these networks become cluster heads, aggregating the data from their members and sending it to the sink. We assume that some sensor nodes have additional energy resources, which is a source of heterogeneity that can arise from the initial configuration or as the network's operation changes. We also assume that the sensor field's dimensions and sink coordinates are known, that the sensors are stationary and that they are randomly (uniformly) distributed. We demonstrate that, in the presence of node heterogeneity, the behavior of such sensor networks becomes extremely unstable after the first node dies. Because they assume that all nodes have the same amount of energy, traditional clustering protocols are unable to fully exploit the presence of node heterogeneity. For many applications where the feedback from the sensor network must be reliable, we propose SEP, a heterogeneous-aware protocol to extend the stability period (the time before the first node dies). SEP is built on the weighted election probabilities of each node to become cluster heads based on how much energy is left in each node. By simulation, we demonstrate that SEP always has a longer stability period than current clustering protocols and has a higher average throughput. We finish up by concentrating on the sensitivity of our SEP convention to heterogeneity boundaries capturing energy awkwardness in the organization. For higher values of additional energy supplied by more powerful nodes, we discovered that SEP produces a longer stability region.

They proposed SEP (Stable Political Decision Convention) so every sensor node in a heterogeneous two-level progressive organization independently elects itself as a group head in light of its underlying energy relative to that of different hubs. In contrast to [17], we do not require global energy knowledge for each election round. SEP is dynamic in contrast to [7, 14 because we do not assume a prior distribution of the various levels of energy in the sensor nodes. Additionally, our SEP analysis is not just asymptotic; rather, it is applied to both large and small networks. SEP is currently being extended to handle clustered sensor networks with more than two types of nodes and more than two levels of hierarchy. In addition, they are examining deployment issues, such as dynamic updates of weighted election probabilities based on current heterogeneity conditions, as well as implementing SEP in Berkeley/Crossbow models. SEP code and results are openly accessible at http://csr.bu.edu/sep.

[17] was the first study to question the behavior of clustering protocols in clustered wireless sensor networks with heterogeneity. Heinzelman looked at a way to select cluster heads based on how much energy is left in each node in this work. The fact that this decision was made per round and assumed that the network's remaining total energy was known is a drawback of this approach. The intricacy and the supposition of worldwide information on the energy left for the entire organization make this technique challenging to carry out. Indeed, even a unified methodology of this strategy would be very complicated and extremely sluggish, as the criticism ought to be dependably delivered to every sensor in each round.

In [7], Duarte-Melo and Liu analyzed the exhibition and energy consumption of remote sensor organizations, in a field where there are two kinds of sensors. They consider fewer hubs but all the more remarkable that have a place with an overlay. These overlay nodes aggregate the data and send it to the sink, and all other nodes are required to report to them. The fact that there is no dynamic selection of the cluster heads between the two types of nodes is a drawback of this approach. As a result, weaker nodes will die first. The creators gauge the optimal percentage of strong hubs in the field, yet this outcome is very hard to utilize when heterogeneity is a consequence of the activity of the sensor network and not a decision of an ideal setting.

A cost-based comparison of homogeneous and heterogeneous clustered wireless sensor networks was presented by Mhatre and

Rosenberg in [14]. They proposed a technique to gauge the ideal distribution among various sorts of sensors, yet again this outcome is hard to use on the off chance that the heterogeneity is because of the activity of the organization. In addition, they looked into the case of multi-hop routing within each cluster, also known as M-LEACH. Even though not all of the powerful nodes are utilized in each round, the method's drawbacks include the fact that only powerful nodes can serve as cluster heads, as well as the fact that M-LEACH is valid under numerous assumptions and only when the population of the nodes is very large.

Li Qing and Co. 2006) [3], The clustering algorithm is one important method for saving energy. It can build the adaptability and lifetime of the network. Homogeneous wireless sensor networks should be taken into account when developing energy-efficient clustering protocols. DEEC, a brand-new distributed energy-efficient clustering method for heterogeneous wireless sensor networks, is the subject of our proposal and evaluation. The probability of selecting the cluster heads in DEEC is determined by comparing the network's average energy to the residual energy of each node. The ages of being group set out toward hubs are different as per their underlying and remaining energy. Compared to nodes with low energy, those with high initial and residual energy will have a greater chance of being cluster heads. In conclusion, the outcomes of the simulations demonstrate that, in heterogeneous environments, DEEC produces messages with a longer lifetime and is more efficient than current important clustering protocols.

They talk about DEEC, a protocol for adaptive clustering that is energy-aware and used in heterogeneous wireless sensor networks. Every sensor node in DEEC chooses independently to be the cluster head based on its initial and residual energy. To control the energy consumption of hubs by implying adaptive methodology, DEEC utilizes the typical energy of the network as the reference energy. Therefore, DEEC does not require global energy knowledge at each election round. DEEC, in contrast to SEP and LEACH, can operate effectively in multi-level heterogeneous wireless sensor networks. Clustering schemes can be divided into two categories. Homogeneous schemes refer to clustering algorithms used in homogeneous networks, whereas heterogeneous clustering schemes refer to clustering algorithms used in heterogeneous networks. It is challenging to devise an energy-proficient heterogeneous bunching plan due to the confounded energy design and organization activity. Therefore, the majority of the current clustering algorithms, such as LEACH [10], PEGASIS [11], and HEED [12], are homogeneous schemes.

Data aggregation and long-distance transmission to the faraway base station require more energy from the cluster heads. The LEACH protocol selects cluster heads periodically and uses role rotation to evenly drain energy. A cluster-head distribution is determined by the probability of each node. Under the homogeneous network, Filter performs well, however, its performance become serious in the heterogeneous networks shown by [9]. Each node in PEGASIS will be organized into a chain, which can be computed by the base station or by each node. The prerequisite of worldwide information of the network geography makes this strategy challenging to carry out. The distributed clustering algorithm HEED randomly selects the cluster heads. The residual energy correlates with each node's selection probability. However, the low-energy nodes in HEED may have a greater selection probability than the high-energy nodes in heterogeneous environments. The heterogeneity of hubs in the wording of their energy is considered in our DEEC, which is designed for heterogeneous organizations. Meanwhile, DEEC preserves the advantages of distributed clustering algorithms.

Estrin et al. [ 18] examine various leveled grouping methods with accentuation on restricted conduct and the need for asymmetric correspondence and energy protection in sensor networks. They propose utilizing the leftover energy level of a hub for bunch head choice. In [10], it is proposed to choose the bunch that makes a beeline for the energy left in every hub. We call this grouping convention Drain E.

The disadvantage of Filter E is that it requires the assistance of directing convention, which ought to permit each node to know the absolute energy of the organization. SEP [9] was made for two-level heterogeneous networks, which have two types of nodes based on their initial energy, i.e., the normal and advanced nodes. The initial energy of nodes is directly correlated with the probability of a rotating epoch and election. SEP performs ineffectively in multi-level heterogeneous organizations and when heterogeneity is a result of the activity of the sensor organization. Each node's epoch as a cluster head is determined by its initial and residual energy by our DEEC protocol. In DEEC, a specific algorithm is used to estimate the lifetime of the network, avoiding the need for routing protocol assistance.

Recently, numerous LEACH-like algorithms have been proposed to boost LEACH's performance. The sensors are organized using a randomized clustering method in the research that the authors conducted [13] on multi-hop clustered networks. They offer techniques for determining the ideal algorithm parameter values. The case of multi-hop routing within each cluster, known as M-LEACH, is the subject of research by Mhatre and Rosenberg [14]. In M-Filter, just strong hubs can turn into group heads. Through local radio communication, EECS [15] selects the cluster heads with more residual energy. EECS takes into account the tradeoff between sending energy from nodes to cluster heads and from cluster heads to the base station during the cluster formation phase. On the other hand, it makes global knowledge of the distances between the cluster heads and the base station more important. A novel adaptive strategy for selecting cluster heads and varying their election frequency in response to the dissipated energy is proposed in LEACH-B [16]. The simulation results indicate that LEACH-B's improvement is limited.

Brahim Elbhiri and others ( 2010) [4] A wireless sensor network typically consists of a significant number of low-cost, power-constrained sensors that collect environmental data and transmit it cooperatively to the base station. It is difficult to conserve energy and, as a result, extend the wireless sensor network's lifespan. These are the majority of the applications for clustering methods. For heterogeneous wireless sensor networks, we present and evaluate a clustering strategy known as a Developed Distributed Energy-Efficient Clustering scheme. This strategy depends on changing dynamically and with more proficiency the bunch head political decision likelihood. Our protocol outperforms the Stable Election Protocol (SEP) by about 30% and the Distributed Energy-Efficient Clustering (DEEC) by about 15% in terms of network lifetime and first node dies, according to simulation results.

They have made sense of the DDEEC convention which is a Developed Distributed Energy-Proficient Grouping for heterogeneous wireless sensors. It is an energy-aware adaptive clustering protocol that uses the average energy of the network as the reference energy, similar to DEEC. It also has an adaptive approach. when, in each election round, each sensor node chooses itself independently as cluster head based on its initial and residual energy without having global knowledge of energy. To increment more DEEC convention performances, the DDEEC executed a decent and dynamic approach to distribute the burned-through effort all the more impartially between hubs. These modifications presented extends better the exhibitions of our DDEEC convention more than the others.

ParulSainiet. al. ( 2010),[5] Numerous clustering-based routing protocols have been proposed in recent years. In ongoing advances, achieving energy effectiveness, lifetime, arrangement of nodes, adaptation to non-critical failure, dormancy, in short, high reliability

and strength have turned into the primary examination goals of remote sensor organization. Many steering conventions on clustering structure have been proposed in recent years in light of heterogeneity. To improve the stability and longevity of the network, we recommend EDEEC for three different types of nodes. As a result, the network's heterogeneity and energy level rise. The simulation results demonstrate that EDEEC outperforms SEP in terms of performance, stability, and message effectiveness.
Sensor nodes and wireless communication make up a wireless sensor network. The organization ought to be energy productive with dependability and a longer lifetime. In this paper, the proposed E-DEEC adds heterogeneity in the organization by presenting the super nodes having energy more than ordinary and advanced nodes and separate probabilities. Reproduction results show that E-DEEC has better execution as compared to SEP as far as boundaries are utilized. I text terminates the network's stability and lifespan.

Heinzelman et al. for uniform wireless sensor networks al. [ 17] introduced Low Energy Adaptive Clustering Hierarchy (LEACH), a sensor network-specific hierarchical clustering algorithm. LEACH is a cluster-based protocol that includes distributed cluster formation. Filter arbitrarily selects a few sensor hubs as group heads (CHs) and rotates this job to equally circulate the energy load among the sensors in the organization [1]. PEGASIS [11] is a chain-based convention that dodges group development and uses only one hub in a chain to send to the BS instead of utilizing various hubs.

Manjeshwaret. al. proposed Limit sensitive Energy Productive sensor Organization convention (Youngster) [20].TEEN seeks various leveled approaches alongside the use of an information-driven system. Two thresholds are sent to the nodes by the cluster head. For sensed attributes, these thresholds are hard and soft. Because the user may not receive any data at all if the thresholds are not met, TEEN is not a good choice for applications that require periodic reports.

Manjeshwaret. al. The Versatile Edge sensitive Energy Productive Sensor Organization convention (APTEEN)[21] focuses on both catching intermittent information assortments and reacting to time-basic occasions. The design is identical to that of TEEN. The overhead and complexity of forming clusters at multiple levels, implementing threshold-based functions, and dealing with attribute-based query naming are the primary drawbacks of TEEN and APTEEN.

Heinzelman and co al. [ 10] proposed LEACH centralized(LEACH-C), a protocol with the same steady state protocol as LEACH and a centralized clustering algorithm. SEP (Stable Election Protocol) [9] proposes that each sensor node in a heterogeneous two-level hierarchical network independently chooses itself to be the cluster head based on its initial energy in comparison to that of other nodes.

Li Qing and co al. proposed the DEEC (Distributed energy efficient Clustering) algorithm, which selects the cluster head based on the probability of the ratio between the network's average energy and residual energy. Reproductions show that its presentation is superior to different conventions.

SBDEEC (Stochastic and Balanced Developed Distributed Energy-Efficient Clustering) was proposed by B. Elbhiri et al. [22]. SBDEEC introduces a balanced and dynamic method with a more effective cluster head election probability. In addition, it extends the lifetime of the network by employing stochastic scheme detection. In terms of network lifetime, simulation results demonstrate that this protocol performs better than the Stable Election Protocol (SEP) and Distributed Energy-Efficient Clustering (DEEC). Our E-DEEC (Upgraded Dispersed Energy Efficient Bunching) conspire depends on DEEC with the addition of super hubs. The DEEC has been extended to three levels of heterogeneity by us. The simulation results show that E-DEEC performs better than SEP, which uses a three-level scheme that is too complicated.

Qureshiet T. N. al. ( 2012),[6] Wireless sensor networks (WSNs) consist of numerous sensor nodes with limited power resources that transmit data to the Base Station (BS) while consuming a significant amount of energy. In this regard, numerous energy-saving routing protocols have been proposed for a variety of scenarios. However, heterogeneous WSNs necessitate specific protocols. When heterogeneity parameters are changed, the protocol's efficiency decreases. Distributed Energy-Efficient Clustering (DEEC), Developed DEEC (DDEEC), Enhanced DEEC (EDEEC), and Threshold DEEC (TDEEC) are the first to be tested in this paper under a variety of different scenarios that range from high-level heterogeneity to low- level heterogeneity. We pay close attention to the performance in terms of throughput, stability, and network lifetime. In terms of lifetime, EDEEC and TDEEC perform better in all-heterogeneous scenarios with variable heterogeneity; however, TDEEC is the best for the network's stability period. However, altering the heterogeneity parameters of the network has a significant impact on the performance of DEEC and DDEEC.
For heterogeneous WSNs with varying degrees of heterogeneity, they have examined DEEC, E-DEEC, T-DEEC, and DDEEC. DEEC and DDEEC perform well in networks with high energy differences between normal, advanced, and supernodes, as demonstrated by simulations. While we find out that EDEEC and TDEEC perform well in all situations. TDEEC has the best execution as far as strength period and lifetime yet the flimsiness time of EDEEC and extremely enormous. Therefore, EDEEC and TDEEC gain stability over time without sacrificing lifetime. On the subject raised earlier, additional research is possible.

Heinzeman, et al. [ 17] presented a bunching algorithm for homogeneous WSNs called Drain in which nodes randomly select themselves to be CHs and ignore this selection models the whole organization to disseminate energy load.

G. Smaragdakis and Others 9] proposed a protocol known as SEP in which each sensor node in a heterogeneous two-level hierarchical network chooses itself as a CH independently based on its initial energy in comparison to other nodes.

Working on heterogeneous WSN, L. Qing, Q. Zhu, and M. Wang [11] proposed a protocol called DEEC, in which CH selection is based on the probability of the network's ratio of residual energy to average energy.

Brahim Elbhiri and others [ 22] researched heterogeneous WSNs and proposed the DDEEC protocol, which is based on residual energy for CH selection to balance it across the entire network. Therefore, the advanced nodes have a higher probability of being chosen as CH for the initial transmission rounds, and as their energy decreases, these nodes will have the same probability of being chosen as CH as normal nodes.

P. Saini et al. [ 23] proposed the protocol EDEEC, which adds super nodes, an additional energy level, to accommodate three-level heterogeneity.

The protocol TDEEC scheme, proposed by Parul Saini and Ajay K Sharma [8], selects the CH from the high-energy nodes, thereby increasing the network's lifetime and energy efficiency.

ParulSainiet. al. ( 2010),[8] In more recent developments, numerous heterogeneous-based routing protocols have been proposed with primary research objectives such as energy efficiency, lifetime, deployment of nodes, fault tolerance, latency, or high reliability and robustness. The TDEEC (Threshold Distributed Energy Efficient Clustering) protocol is the energy-efficient cluster head scheme that we have proposed in this paper for heterogeneous wireless sensor networks. It works by adjusting a node's threshold value to determine whether it is a cluster head or not. The simulation results demonstrate that the proposed algorithm outperforms the alternatives.
The TDEEC (Threshold Distributed Energy Efficient Clustering) protocol was proposed in this paper to increase the lifetime and stability of the heterogeneous wireless sensor network. Reproduction results show that TDEEC performs better when contrasted with SEP and DEEC in heterogeneous climates for remote sensor organizations.

Heinzelman and co al. [ 17] introduced Low Energy Adaptive Clustering Hierarchy (LEACH), a hierarchical clustering algorithm for wireless sensor networks with homogeneity. LEACH is a cluster-based protocol that includes the formation of distributed clusters. Drain haphazardly chooses a few sensor hubs as group heads (CHs) and turns this job to evenly distribute the energy load among the sensors in the organization [1].PEGASIS [11] is a chain-based convention that dodges cluster formation and uses just a single hub in a chain to send to the BS instead of utilizing various hubs.

Manjeshwaret. al. proposed the TEEN protocol, which stands for threshold-sensitive Energy-Efficient sensor Network [20]. TEEN employs a data-centric mechanism and a hierarchical strategy. Two thresholds are broadcast to the nodes by the cluster head in TEEN. For sensed attributes, there are these hard and soft thresholds. the Youngster isn't great for applications where occasional reports are required since the client may not get any information whatsoever assuming the thresholds are not reached. Manjeshwaret. al. then came up with the Adaptive Threshold Sensitive Energy Efficient Sensor Network Protocol (APTEEN) [21], which aims to both collect data o regularly and respond to events that are crucial to the clock. The design is identical to that of TEEN. The primary disadvantages of TEEN and APTEEN are the above and the intricacy of forming clusters in numerous levels executing limit-based functions and managing property-based naming of questions.

Heinzelman and others [ 10]proposed LEACH-centralized (LEACH-C), a steady-state protocol identical to LEACH that makes use of a centralized clustering algorithm. O. Younis et al. [12] proposed HEED (Hybrid Energy-Efficient Distributed Clustering), which selects cluster heads periodically based on a combination of the node's residual energy and a secondary parameter like the node's proximity to its neighbors or degree. SEP (Stable Election Protocol) [9] was proposed by G. Smaragdakis, I. Matta, and A. Bestavros. Under this method, each sensor node in a heterogeneous two-level hierarchical network chooses itself as a cluster head based on its initial energy in comparison to that of other nodes. Li Qinge and Co. [ 19] Proposed a DEEC (Conveyed energy proficient Clustering)algorithm in which the group head is chosen on the premise of the probability of the proportion of remaining energy and normal energy of the network. It performs better than other protocols, as demonstrated by simulations.

ALEACH (Advanced LEACH), a novel method that takes into account both current state probability and general probability, was proposed by Md. Solaiman Ali et al. [24]. Sajjanhar and Co. 25] proposed the Distributive Energy Efficient Adaptive Clustering (DEEAC) Protocol, which has spatial and temporal differences in the rates at which data are reported in various regions. DEEAC selects a node for the role of cluster head based on its residual energy and hotness value.

SDEEC (Stochastic Distributed Energy-Efficient Clustering) was proposed by B. Elbhiri et al. [26]. SDEEC introduces a balanced and dynamic method with a more effective cluster head election probability. Besides, it utilizes a stochastic scheme location to expand the organization's lifetime. In terms of network lifetime, simulation results demonstrate that this protocol performs better than the Stable Election Protocol (SEP) and the Distributed Energy-Efficient Clustering (DEEC). InboSim, et.al [27] proposed ECS (Energy effective Cluster header Determination) calculation which chooses CH by using just its information to expand network lifetime and limit additional overheads in energy-restricted sensor organizations. Mama Chaw MonThein, et.al [28] proposed a change of the LEACH's stochastic group head choice calculation by considering the additional boundaries, the remaining energy of a node relative to the residual energy of the organization for adjusting bunches and rotating cluster head positions to equitably convey the energy load among all the hubs. The primary objective of the threshold distributed energy-efficient clustering (TDEEC) algorithm that we have proposed is to improve the stability and energy efficiency of heterogeneous wireless sensor networks.

**Conclusion:** WSN has been developed and utilized in a variety of fields. Various approaches have been taken to improve the WSN innovation's QOS. This paper has focused on the different applied computations that have been applied to recently deal with the QOS.

**Acknowledgment**: I wish to express my gratitude to Assistant Professor Er. Abhishek Srivastava, who served as my thesis advisor, for his guidance, advice, and support during the composition of my thesis. I want to express my gratitude to him for being my mentor, teaching me, and motivating me to advance my knowledge. I am grateful for the helpful guidance from the Department of Electronics and communications engineering staff.
when this thesis has been completed. Above all, I want to thank God for providing me with the courage, skills, and confidence I needed to complete the task. I owe a lot to my parents, especially for their support, love, and patience.

**References :**
[1] Jamal N. Al-Karaki, Ahmed E. Kamal," Routing Techniques In Wireless Sensor Networks: A Survey", IEEE Wireless

Communications, Volume: 11, Issue: 6, 26- 28, December 2004.
[2]. Georgios Smaragdakis, Ibrahim Matta, Azer Bestavros, "SEP: A Stable Election Protocol for clustered wireless sensor networks", Computer Science Department, Boston University, Boston, MA 02215, USA
[3]. Li Qing *, Qingxin Zhu, Mingwen Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks", School of Computer Science and Engineering, University of Electronic Science and Technology of China, Chengdu 610054, PR China
[4]. Brahim Elbhiri, SaadaneRachid, Sanaa Elfkihi, "Developed Distributed Energy-Efficient Clustering (DDEEC) for heterogeneous wireless sensor networks"
[5]. Ajay.K.Sharma, Department of Computer Science & Engineering, Parul Saini, Department of Computer Science & Engineering, "E-DEEC- Enhanced Distributed Energy Efficient Clustering Scheme for Heterogeneous WSN"
[6]. T. N. Qureshi, N. Javaid, M. Malik, U. Qasim, Z. A. Khan, "On Performance Evaluation of Variants of DEEC in WSNs".
[7] E. J. Duarte-Melo and M. Liu. Analysis of energy consumption and lifetime of heterogeneous wireless sensor networks. In Proceedings of Global Telecommunications Conference (GLOBECOM 2002), pages 21–25. IEEE, November 2002.
[8]. Parul Saini, Ajay K Sharma, "Energy Efficient Scheme for Clustering Protocol Prolonging the Lifetime of Heterogeneous Wireless Sensor Networks"
[9] G. Smaragdakis, I. Matta, A. Bestavros, SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks, in Second International Workshop on Sensor and Actor Network Protocols and Applications (SANPA 2004), 2004.
[10] W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, An application-specific protocol architecture for wireless microsensor networks, IEEE Transactions on Wireless Communications 1 (4) (2002) 660–670.
[11] S. Lindsey, C.S. Raghavendra, PEGASIS: power-efficient gathering in sensor information systems, in Proceeding of the IEEE Aerospace Conference, Big Sky, Montana, March 2002.
[12] O. Younis, S. Fahmy, HEED: A hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks, IEEE Transactions on Mobile Computing 3 (4) (2004) 660–669.
[13] S. Bandyopadhyay, E.J. Coyle, An energy-efficient hierarchical clustering algorithm for wireless sensor networks, in Proceeding of INFOCOM 2003, April 2003.
[14] V. Mhatre, C. Rosenberg, Design guidelines for wireless sensor networks: communication, clustering and aggregation, Ad Hoc Network Journal 2 (1) (2004) 45–63.
[15] M. Ye, C. Li, G. Chen, J. Wu, EECS: an energy-efficient cluster scheme in wireless sensor networks, in IEEE International Workshop on Strategies for Energy Efficiency in Ad Hoc and Sensor Networks (IEEE IWSEEASN2005), Phoenix, Arizona, April 7–9, 2005.
[16] A. Depedri, A. Zanella, R. Verdone, An energy-efficient protocol for wireless sensor networks, in Autonomous Intelligent Networks and Systems (AINS 2003), Menlo Park, CA, June 30–July 1, 2003.
[17] W. R. Heinzelman. Application-Specific Protocol Architectures for Wireless Networks, Ph.D. thesis, Massachusetts Institute of Technology, 2000.
[18] D. Estrin, R. Govindan, J. Heidemann, S. Kumar, Next century challenges: scalable coordination in sensor networks, in Proceedings of the 5th Annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom'99), August 1999, pp. 263–270.
[19] L. Qing, Q. Zhu, M. Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks". ELSEVIER, Computer Communications 29, 2006, pp 2230- 2237.
[20] A. Manjeshwar and D. P. Agarwal, "TEEN: a routing protocol for enhanced efficiency in wireless sensor networks," In 1st International Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, April 2001.
[21] A. Manjeshwar and D. P. Agarwal, "APTEEN: A hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks," Parallel and Distributed Processing Symposium., Proceedings International, IPDPS 2002, pp. 195-202.
[22] Elbhiri, B., Saadane, R., El Fkihi, S., Aboutajdine, D. "Developed Distributed Energy-Efficient Clustering (DDEEC) for heterogeneous wireless sensor networks", in 5th International Symposium on I/V Communications and Mobile Network (ISVC), 2010.
[23] Parul Saini, Ajay.K.Sharma, "E-DEEC- Enhanced Distributed Energy Efficient Clustering Scheme for heterogeneous WSN", in 2010 1st International Conference on Parallel, Distributed and Grid Computing (PDGC - 2010).
[24] Md. Solaiman Ali, Tanay Dey, and Rahul Biswas, ―ALEACH: Advanced LEACH Routing Protocol for Wireless Microsensor Networks‖ ICECE 2008, 20-22 December 2008.
[25] U. Sajjanhar, P. Mitra, ―Distributive Energy Efficient Adaptive Clustering Protocol for Wireless Sensor Networks‖, Proceedings of the 2007 International Conference on Mobile Data Management, pp. 326 - 330, 2007.
[26] Elbhiri Brahim, Saadane Rachid, Alba-Pages Zamora, Driss Aboutajdine, ―Stochastic Distributed Energy-Efficient Clustering (SDEEC) for heterogeneous wireless sensor networks‖, ICGST-CNIR Journal, Volume 9, Issue 2, December 2009.

[27] Inbo Sim, KoungJin Choi, KoungJin Kwon and Jaiyong Lee, ―Energy Efficient Cluster header Selection Algorithm in WSN‖, International Conference on Complex, Intelligent andSoftware Intensive Systems , IEEE, 2009.
[28] Ma Chaw Mon Thein, Thandar Thein ―An Energy Efficient Cluster-Head Selection for Wireless Sensor Networks‖, International Conference on Intelligent Systems, Modeling, and Simulation, IEEE 2009.