

# Analysis of Clustering Mechanism to Increase Energy Efficiency within Wireless Sensor Network (WSN)

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## ABSTRACT

The evaluation and up gradation of wireless sensor Network (WSN) requires transfer of data from source to destination. Nodes within wireless network are sensors having limited energy associated with them. Nodes collaborating together form clusters. Data transmission takes place from distinct clusters towards base station. Energy of sensors needs to be preserved in order to enhance lifetime of network. This paper presents the overview of various existing techniques used to enhance lifetime of network. The degradation indicated in terms of packet drop ratio for determining network bandwidth. The analysis of some popular protocols has been done in this paper which can be used for future enhancements.

## Keywords

WSN, Clusters, bandwidth, Packet drop ratio

## 1. INTRODUCTION

Wireless sensor network [1] consists of spatially distributed devices used to maintain physical or environmental conditions. Nodes used within WSN could be of distinct configuration. These nodes form heterogeneous environment. Heterogeneous [2][3] environment requires protocols in order to establish communication among distinctly configured nodes. IEEE 802.11 standards established for Wi-Fi connectivity is commonly used protocol for transmission within WSN. Nodes following common protocols form clusters. Physically nearness at the specific area may not be plausible. For this reason client depends vigorously on innovation. The cell system is accomplished with the assistance of confinement. The restriction thusly is finished by the utilization of obscure hubs and stay hubs. The grapple hubs are those through which data about the obscure hubs can be gotten. The obscure hub position at the end of the day will rely on the stay hub positions. It has much real application in agribusiness explore. It gives full administration of remote sensor items, programming advancement and arranged counseling administrations to business.

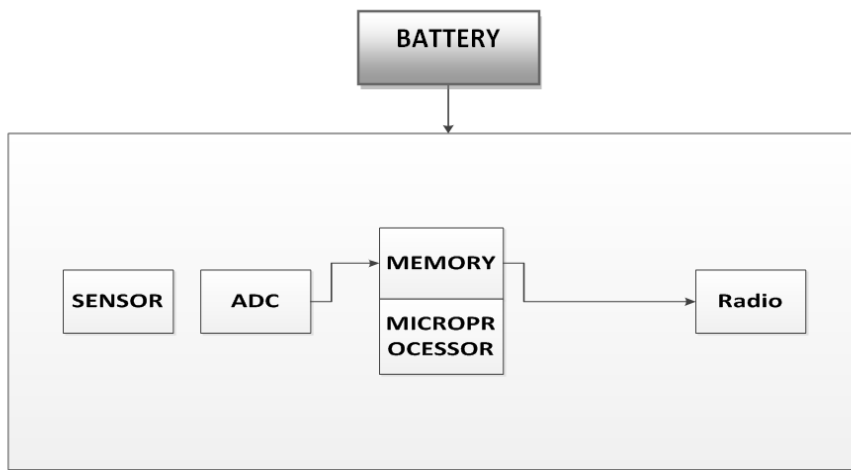
Remote correspondence comprises of hubs which are in charge of transmission of data from source to the goal without utilizing wired component. The Sensor hubs are utilized for this reason. The sensor hubs will transmit the data to the following hub in arrangement whose span crosses with the other sensor hub range. The provisions for hubs are broad. Point must be minimized, vitality powerful, multifunctional, and remote. At the point when all these point associated their shape arrange and by this the principle thought process can be gotten. For instance, if there is a data accessible for need of water among all segments of the field, put the focuses are in the dirt to frame a system. After it system can accumulate information and transmit information to primary PC.

Sensor is utilized as a part of the home likewise, for example, cooler and microwave. These are brilliant machines we can set its planning when nourishment is get ready then it consequently give caution.

Remote Sensor Network is more advantageous and more noteworthy focal points over regular wired Sensor. They are utilized as a part of any condition particularly when regular wired sensors are unrealistic. They additionally diminished the cost and postponement.

In WSN there is no need that system site get close to it we can impart the system site get a long way from this. Remote sensor organizes gather information which is in vogue, and we get data about the information. Sensor unit comprise of Analog to advanced converter. The ADC will get the simple flag and changes over it into the computerized shape. The advanced information has greater lucidity related with it. The sensor hubs will be influenced by number of parameters. The parameters will choose the lucidity by which transmission happens. The parameters are separated into following classes:

- Temperature
- Dampness
- Vibration



**Figure 1: Wireless Sensor Network Operation(Chaouchi & Marie n.d.)**

## 2. ENERGY EFFICIENT CLUSTERING TECHNIQUES IN WSN

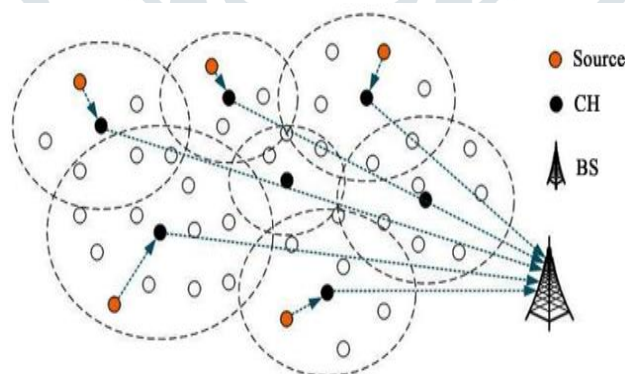
Large number of protocols researched over a decade to enhance lifetime associated with the network. This section discusses various protocols falls under energy efficient category.

### 2.1 Low Energy Adaptive Clustering Protocol (LEACH)

Low Energy Adaptive Clustering hierarchical protocol [4],[8] is used to enhance energy efficiency associated with transfer process. Time division multiple access protocol is integrated within LEACH. Cluster head selection is a problem within LEACH. In fact cluster head selection does not take place and data is transmitted from transmitter towards random selection of node selected as head. Aggregation is performed at cluster head and when threshold value is reached, packets are transmitted forward. In case cluster head energy dissipated completed, all the packets aggregated at node will be lost. Properties associated with LEACH are listed as under

- Hierarchical in nature
- Random Cluster Head Selection is involved
- Adaptive membership of cluster
- Aggregation of data at cluster head
- Communication involves nodes and cluster head
- Threshold values involve during transmission

LEACH protocol is represented as under



**Figure 1: Leach Protocol(Cheikh et al. 2014)**

### Distributed Energy Efficient Clustering Protocol(DEEC)

This protocol[9][10] is advancement associated with LEACH. Cluster head selection is complex in case of DEEC. Maximum energy nodes are elected among available nodes. The node with the highest probability of conserving energy is selected as cluster head. A distributed multilevel clustering algorithm for heterogeneous wireless sensor networks is considered with following characteristics

- The cluster head is elected by a probability based on the ratio between the amount residual energy present at each node and the average energy of the network.
- The lifetime of a cluster head is decided according to its initial energy and residual energy. So always the nodes with high initial and residual energy have a better chance to become a CH.

- DEEC is implemented based on the concepts of LEACH algorithm. The role of cluster head is rotated among all nodes of the network to make energy dissipation uniform.
- Two levels of heterogeneous nodes are considered in this algorithm to achieve longer network lifetime and more effective messages than other classical clustering algorithms.
- It also works better for multilevel heterogeneous networks.

In DEEC, all the nodes must have the idea about total energy and lifetime of the network. Average energy of the network is used as the reference energy.

DEEC protocol is represented through the following figure

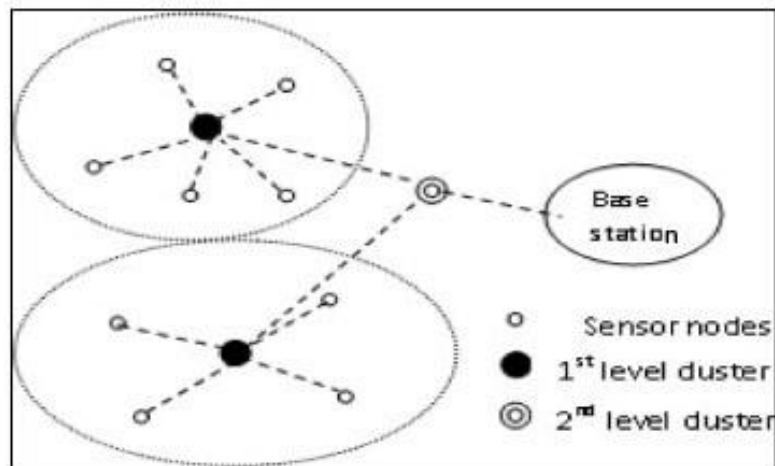


Figure 2: DEEC protocol(Cheikh et al. 2014)

### 1.1 Stability Election Protocol(SEP)

SEP[10] concentrate the effect of heterogeneity of Clusters, as far as their vitality, in remote sensor arranges that are progressively bunched. Following properties are considered

- In these systems a portion of the nodes progressed toward becoming bunch heads, total the information of their group individuals what's more, transmit it to the sink.
- It accept that a rate of the populace of sensor hubs is outfitted with extra vitality assets which is a wellspring of heterogeneity which may come about from the underlying setting or as the operation of the system advances.
- It additionally consider the sensors are arbitrarily (consistently) appropriated and are not versatile, the directions of the sink and the measurements of the sensor field are known.
- It is assumed in SEP that nodes cannot take full favorable position of the nearness of hub heterogeneity.
- SEP, a heterogeneous-mindful convention to draw out the time interim before the passing of the principal hub (we allude to as strength period), which is pivotal for some applications where the criticism from the sensor organize must be solid.
- SEP depends on weighted race probabilities of every hub to end up bunch go to the rest of the vitality in every hub.

SEP[11], [12] is advancement associate with DEEC. Energy is conserved and lifetime of network is improved considerably by the use of this protocol.

Representation of SEP is as under

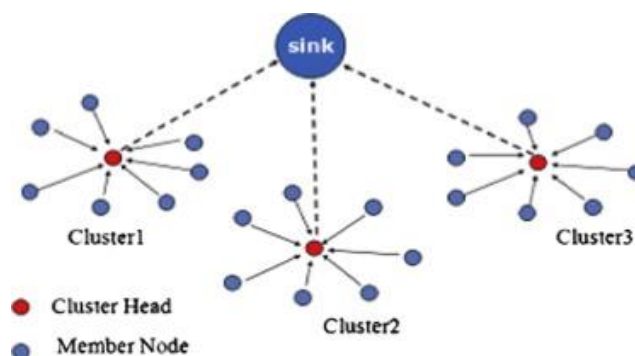


Figure 3: Representation of SEP(Cheikh et al. 2014)

## 1.2 Enhanced Distributed Energy Efficient Clustering Protocol (EDEEC)

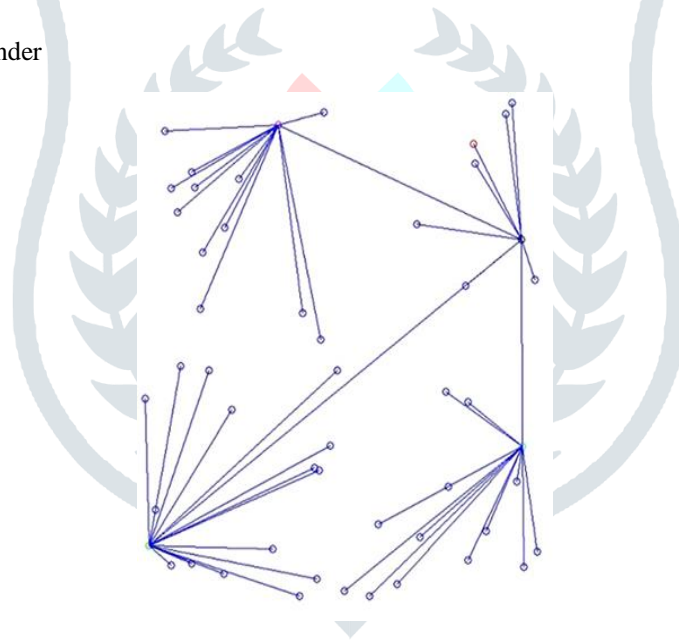
Remote Sensor Networks (WSNs)[13]–[15] comprises of across the board arbitrary sending of vitality obliged sensor hubs. Following properties exists of EDEEC.

- Sensor hubs have distinctive capacity to detect and send detected information to Base Station (BS) or Sink.
- Detecting and in addition transmitting information towards sink requires substantial measure of vitality.
- In WSNs, save vitality and delaying the lifetime of system are incredible difficulties. Many directing conventions have been proposed with a specific end goal to accomplish vitality productivity in heterogeneous condition.
- EDEEC for the most part comprises of three sorts of hubs in amplifying the lifetime and solidness of system.

Enhanced distributed energy efficient clustering protocol is advancement of DEEC that conserve energy and reduce packet drop ratio considerably. Further enhancement in DEEC can be made to enhance performance DEEC by reducing distance between nodes in which data is being transmitted.

Today's world needs some technologies to fulfil their routine work. WSN[16] is that technology which fulfills the routine work of the society. Wireless sensor network senses the physical world whether it is temperature, pressure, humidity and some other environment activities. WSN is used in an environment where the wires or cable are not possible to reach. It is easy to install compared with the other cables network. Now, these day's WSN are using mainly for the data transfer purpose. Sensor nodes[17] in the wireless network transfer the data packets from source to destination. Wireless sensor network includes sensors nodes and a base station (sink) and there are so many sensors which create a network. All the sensor nodes in a network communicate with each other and transfer the data packet from source node to the sink. Sensor nodes can communicate directly with the base station. Sensor nodes consume a lot of energy while data transfer. On the other hand, sensor nodes also consume energy after transferring the data packets. Due to this consumption, the lifetime of the network also gets reduced. This is the major issue of the sensor network. There[18] are more issues of the network but energy consumption and improve the lifetime of the network. Taking these issues in concern, there is one method which is very much useful to resolve these problems called clustering. Clustering, the technique in which large network region is divided into smaller one. With this technique, sensor nodes do not require direct communication with the base station.

Representation of EDDEC is as under



**Figure 4: Representation of EDEEC(Preethi et al. 2016)**

Next section describes background analysis or literature survey to determine best possible protocol for future enhancement.

## 2. Earlier Work

Techniques have been devised for improvement of performance in WSN. The WSN performance is critically analyzed using this paper. The worth of study is proved using this literature survey.

S. Kumar [19] in 2014 has been proposed distance and energy aware LEACH. The cluster head selection in this approach was adaptive and allow packet drop ratio to reduce considerably. The aggregation mechanism was the drawback associated with this approach. In case cluster head go down, every packet aggregated at source could be lost.

Liu et al. 2009[20] have been proposed EAP for conserving energy during transmission of data from source to destination. Inter cluster coverage was introduced in this approach. Data gathered at particular cluster was according to probability distribution factor that reduces energy consumption and enhances lifetime of network.

Nadeem in 2013 have been discussed energy efficiency achieved through LEACH protocol. Time division MAC was integrated to achieve energy efficiency and lifetime within the WSN.

Prajapat & Barwar 2014[21] have been proposed a mechanism to analyze energy dissipation through Multi-Chain PEGASIS. This protocol constructs a chain of routing path. Multi hop routing was used under PEGASIS. Overall protocol was energy and power efficient but complex. In other words time and space complexity was enhanced using PEGASIS. Future modifications required in order to enhance performance of examined system.

Heinzelman et al. 2000[22] have been proposed LEACH, a hierarchical protocol for achieving energy efficiency within WSN. Adaptive cluster head selection allows performance enhancement however aggregation mechanism used within WSN has merits and demerits associated with it. Energy conservation was achieved with the risk of enhancement of packet drop ration in case of cluster head failure.

R. Kumar [23] has been proposed in 2014 energy efficient DEEC protocol. DEEC protocol uses probability distribution function to determine cluster head out of number of nodes available within WSN. Probability assigned with each node within WSN was analyzed for selection of cluster head. Probability associated with nodes varies during each round. Higher the probability more will be chance of node being selected as cluster head. DEEC performance decreases by the application of aggregation mechanism leading to increase in packet drop ratio.

Saini & Sharma 2010[13] have been proposed enhancement in DEEC protocol to achieve more energy efficiency. Lifetime of network is significantly improved by the application of E-DEEC. As packets moved from one node to another, energy associated with nodes will be analyzed. Node having highest energy will be selected as cluster head. Packet is being received by node having highest energy. Lifetime of network was considerably enhanced but packet drop ratio increases hence requires improvement.

Shah et al. n.d.[9] have been proposed a sleep awake protocol for WSN data transmission. Node being idle was set to sleep and energy conservation was achieved. The problem of topology breakage occurred as node was made to sleep. In order to wake the node sufficient amount of energy was required to be dispensed with.

Preethi et al. 2016[15] have been discussed a super energy aware protocol by accomplishing modifications to the existing DEEC protocol. Modified mechanism of electing cluster head was proposed. Node selected as cluster head was evaluated against several criteria's before electing it as cluster head. Complexity in terms of cluster head was extremely high.

Jan et al. 2014[24] have been proposed a priority based application specific congestion control algorithm. Packets can be initiated through any node and hence traffic could be a problem. To handle traffic, congestion control mechanism was proposed by maintaining priority queue. Packets from distinct nodes were maintained within queue. As congestion becomes high, enqueue operation takes place. As traffic becomes moderate dequeue operation takes place. This mechanism results in decreasing packet drop ratio. But energy consumption in this mechanism still requires improvement.

Nadeem et al. n.d.[25] has been advised gateway based energy routing protocol (M-GEAR) for WSN. Depending on their location in the sensing area, they divided the nodes into four zones. In this protocol, they placed the base station out of the sensing zone and placed a gateway at the middle of the sensing area. The node uses the direct communication if the distance of the sensing node from the base station or gateway is less than the prescribed distance. They also divided the remaining nodes into equal zones. Selected cluster heads in each zone are independent of each other. They compared the performance of proposed protocol with LEACH. Analysis results show that their assigned protocol perform greatly basis on the consumption of energy and lifespan of the network.

Cheikh et al. 2014[26] have been said that in the upcoming time, WSNs require a great need of spreading the nodes and also enhance its applications in all fields because in the future most of the devices will be connected to each and everything. So spreading of these nodes is the greatest challenge, keeping this in mind a new protocol is given called TDEEC used for the heterogeneous network. TDEEC protocols use three levels of heterogeneity. It is a reactive protocol and used basically for reactive networks. Reactive networks are those which react quickly to any change arise in any parameter.

The comprehensive literature survey conducted in this paper suggests, considerable improvement in terms of energy efficiency and packet drop ratio within WSN is required. Some techniques suggested such as DEEC provides efficient low complexity mechanism to accomplish the same but distance based criteria's are absent within DEEC. To improve the performance of DEEC, distance between nodes must be considered. This could be the future course of action.

### 3. COMPARISON OF ENERGY AWARE SCHEMES WITHIN WSN

Comparison of protocols consuming energy, initial energy, number of dead nodes and complexity is given as under

PROTOCOL	YEAR	Number of Rounds	Number of Dead Nodes	Initial Energy	Residual energy	Complexity
Modified LEACH(Prasad et al. 2018)[38]	2017	2000	90 out of 100 after rounds complete	1.5 Joules	0 after all the rounds	High
PAGASIS(Nigam & Dabas 2017)[31]	2017	2000	80 out of 100 after all the rounds	1.5J	0.35 after all the rounds	High
Multi hop Scheduling(Anon 2016)[3]	2016	2000	60 out of 100 after all the rounds	1.5J	0.2 after all the rounds	Low
DCBRP(Marhoon et al. 2016)[28]	2016	2000	85 out of 100 after all the rounds	1.5J	0.15 after all the rounds	High
ECS(Pati et al. 2016)[35]	2016	2000	62 out of 100 after all the rounds	1.5J	0.30 after all the rounds	Low
ELEACH(Arumugam& Ponnuchamy 2015)[5]	2015	2000	70 out of 100 after rounds complete	1.5 J	0.5 after all the rounds	Low
HEED(Chand et al. 2014)[7]	2014	2000	73 out of 100 after all the rounds	1.5J	0.25 after all the rounds	High
SEP(Pal et al. 2013)[34]	2013	2000	80 out of 100 after rounds complete	1.5 J	0.3 after all the rounds	High
TTDD(Luo et al. 2005)[25]	2005	2000	85 out of 100 after all the rounds	1.5J	0.29 after all the rounds	High

**Table 1: Comparison of protocols in terms of energy consumed and complexity**

Comparison of energy aware schemes presented in this section provides clear and concise view of optimal technique within WSN during data transmission.

Protocol	Year	Merits	Demerits	Remarks
Mobile Agent Driven aggregation protocol (Fissaoui et al. 2017)[12]	2017	<ul style="list-style-type: none"> <li>Lower energy consumption in SGLC compared to LEACH</li> </ul>	<ul style="list-style-type: none"> <li>Large overhead due to complex data communication</li> </ul>	It is distributed efficient energy consumption and distribution protocol.
CCM(Ibragimov et al. 2016)[15]	2016	<ul style="list-style-type: none"> <li>Energy consumed in the selection of cluster head is less as compared to leach</li> </ul>	<ul style="list-style-type: none"> <li>Chain head selection is complex and has more overhead associated with it</li> </ul>	Mixture of flat, hierarchical and location based routing is combined
Multi hop Clustering Protocol (Arioua et al. 2016)[4]	2016	<ul style="list-style-type: none"> <li>GAF increase the network lifetime by saving energy</li> <li>Routing fidelity is maintained</li> </ul>	Large traffic injection and delay is not predictable	It is a location based least energy consumption protocol
TDEEC(Pree thi et al. 2016)[39]	2016	<ul style="list-style-type: none"> <li>Modified DEEC Clustering protocol provides better performance in terms of energy consumption then DEEC</li> </ul>	<ul style="list-style-type: none"> <li>Slotting is used hence it is more complex</li> </ul>	DEEC with time division is considered hence overall operation is faster
Energy Optimization Protocol (Li et al. n.d.)[23]	2015	<ul style="list-style-type: none"> <li>Every node in the cluster may become cluster head depending upon the amount of energy node possess</li> <li>Collisions are avoided since leach protocol is accompanied with time division multiple access mechanism</li> </ul>	<ul style="list-style-type: none"> <li>Difficult to implement in large networks</li> <li>Lack of uniformity in selection of cluster head</li> </ul>	Earliest protocol associated with clustering
PANEL(Discipline 2015)[10]	2015	<ul style="list-style-type: none"> <li>Panel is energy efficient that ensure load balancing and long network lifetime</li> <li>Supports asynchronous applications</li> </ul>	<ul style="list-style-type: none"> <li>Clusters are predetermined</li> <li>To determine geographic position information, special conditions are needed, which is not always available</li> </ul>	This is efficient node selection algorithm for handling cluster
TTDD(Rohankar et al. 2015)[41]	2015	<ul style="list-style-type: none"> <li>Resolve the numerous mobile sinks and moving problem of sink in large scale WSNs</li> <li>Suitable to event detecting WSNs among irregular</li> </ul>	<ul style="list-style-type: none"> <li>Large latency</li> <li>Low energy efficiency</li> <li>TTDD require sensor nodes to be stationary and location aware</li> </ul>	It is a two tier energy consumption minimization protocol

		data traffic		
PEGASIS(Science et al. 2015)[22]	2015	<ul style="list-style-type: none"> <li>Uniform load balancing</li> <li>Reduce cluster head selection over head</li> <li>Packet drop ratio decreases</li> </ul>	<ul style="list-style-type: none"> <li>High delays in transmission</li> <li>Scalability is least</li> <li>Time varying topologies make it complex to use</li> </ul>	Load balancing is handled efficiently in this protocol as compared to LEACH
TSC(Xu & Zhao 2015)[48]	2015	<ul style="list-style-type: none"> <li>Redundant data is reduced</li> </ul>	<ul style="list-style-type: none"> <li>Asymmetric node balance</li> </ul>	Modularity is provided by dividing the network into concentric circles hence better energy consumption is achieved
PASCCC(Jan et al. 2014)[17]	2014	<ul style="list-style-type: none"> <li>Priority based data transformation</li> <li>Packet drop ratio is low</li> </ul>	<ul style="list-style-type: none"> <li>Energy consumption is high</li> </ul>	Priority is assigned but starvation problem can be present
SEP(Pal et al. 2013)[34]	2013	<ul style="list-style-type: none"> <li>It is better in terms of packet drop ratio</li> </ul>	<ul style="list-style-type: none"> <li>More complex as compared to leach</li> </ul>	Energy consumption is less as compared to previous algorithm
Clustering protocol for WSN(Singh & Singh n.d.)[46]	2010	<ul style="list-style-type: none"> <li>Solve the problem of area with overlapped sensing coverage and sensing hole</li> <li>In LEACH-VF some nodes can be moved to coverage inside the cluster are</li> </ul>	<ul style="list-style-type: none"> <li>Poor energy efficiency</li> <li>Load balancing is not up to the mark</li> </ul>	Area independence is achieved
Enhanced Energy Efficient Protocol(Ibrahim &Tamer n.d.)[16]	2010	<ul style="list-style-type: none"> <li>Data transmission can be controlled by varying two thresholds</li> <li>Well suited for time critical applications</li> </ul>	<ul style="list-style-type: none"> <li>Whenever thresholds are not meet , the node will not communicate</li> <li>Data may be lost if CHs are not able to communicate with each other</li> </ul>	Hierarchical routing protocol that is used to minimize energy consumption of clustering algorithm
Energy Aware Protocol(Liu et al. 2009)[24]	2009	<ul style="list-style-type: none"> <li>Routing Scheme used is fully distributed</li> <li>Local Communication is supported for least complexity</li> <li>More uniform in nature</li> <li>High Energy Efficiency and reliability</li> </ul>	<ul style="list-style-type: none"> <li>Communication Overhead is high due to random cluster head selection</li> <li>Extra Energy consumption in selection of cluster head</li> </ul>	Better connectivity of cluster heads
Single Hop Clustering	2009	<ul style="list-style-type: none"> <li>Achieve Load Balancing</li> </ul>	<ul style="list-style-type: none"> <li>Communication overhead is</li> </ul>	Energy efficient



protocol(Shahng 2009)[45]		<ul style="list-style-type: none"> <li>Clusters are variable in size</li> </ul>	<ul style="list-style-type: none"> <li>high Energy Consumption is exceedingly high</li> </ul>	protocol used commonly at media access control layer within data link layer
EESSA(Shah et al. n.d.)[44]	2009	<ul style="list-style-type: none"> <li>Dynamic node selection</li> <li>Better than Leach in terms of energy consumption</li> </ul>	<ul style="list-style-type: none"> <li>Complex in nature</li> <li>Lifetime can be further improved</li> </ul>	Better as compared to LEECH
Secure and reliable Routing protocol(Ozdemir 2007)[33]	2007	<ul style="list-style-type: none"> <li>Cluster head formed are heterogeneous</li> <li>Variable sized clusters</li> </ul>	<ul style="list-style-type: none"> <li>Limited Implementation framework</li> <li>Residual energy is low.</li> </ul>	Commonly used protocol in unequal cluster sized environment
CCS(Advisor & Committee 2007)[1]	2007	<ul style="list-style-type: none"> <li>Least Energy Consumption</li> <li>Packet drop ratio decreases</li> </ul>	<ul style="list-style-type: none"> <li>Asymmetric Energy Consumption</li> <li>Time duration is high</li> </ul>	It is network coding based protocol for energy efficiency

**Table 2: Comparison of Techniques of Clustering used within WSN**

From comparison table it is concluded that techniques associated with clustering algorithm within WSN requires considerable improvement in terms of energy conservation and packet drop ratio. Distance handling among WSN is critical for this purpose.

#### 4. CONCLUSION AND FUTURE SCOPE

This paper presents comprehensive survey of techniques used within WSN to achieve increase in lifetime of sensor within WSN. Critical analysis of various efficient protocols used in WSN has been reviewed Enhancement in lifetime involves mechanism such as sleep and wake up protocol but has demerits associated with it. The idle nodes are considered to be sleep and in results there is breakage in functioning of topology. In order to restore the nodes to their initial state sufficient energy is required leading to loss of packets. Secondly the distance conservation mechanism is not considered in DEEC protocol which results in high packet drop ratio. In case of leach aggregation the cluster head causes problem because if cluster head is dead then all packets collected at cluster head are lost automatically. From analysis of existing techniques it is identified that there exist a tradeoff between energy and packet drop ratio. In future this tradeoff between energy and packet drop ratio is to be eliminated by considering distance between nodes before selection of cluster head or by making more than one cluster head. Use of priority queue can also be merged within existing approach for enhancing performance of WSN.

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