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RESEARCH ARTICLE

A REVIEW ON DESCENDANTS OF LEACH PROTOCOL - A PRAGMATIC APPROACH

Dr. R.M. Dilip Charaan[1], Dr. P.R. Therasa[1] and Dr. P. Malathi[2]

1. Teaching Fellow, A.C.Tech, Anna University, Chennai-25.
2. Assistant Professor, Dhanalakshmi Srinivasan College of Engineering and Technology, Mahabalipuram.

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Abstract

A Wireless Sensor Networks (WSN) is a Wireless Networks comprising of spatially disseminated independent sensors to screen physical or natural circumstances. The battery power in these sensor nodes assumes a significant part in expanding the life expectancy of the nodes. Hierarchical routing protocols are the most popular protocols to limit the energy utilization when compared to Flat Routing. Low-Energy Adaptive Clustering Hierarchy (LEACH) is a traditional Cluster based routing protocol for WSNs having great execution, energy productivity, and successful in elongating the lifetime of the network life time by consuming a little level of the complete disseminated energy in the framework. This paper reviews the condition of craft of various progressed, enhanced routing protocols that have been created from the LEACH. This paper features a portion of the downsides and issues of LEACH; how these issues are vanquished by the relatives of LEACH. Appraisal of descendants of LEACH routing protocols in advised with regards to versatility, self-association, and conveyance of nodes, network control, Hop count, energy proficiency, and utilization of data.

Introduction:-

Wireless Sensor Networks (WSN) is an arising innovation for drawing in the scientists with its difficulties and unique application spaces. Remote sensor organization (WSN) is a self-coordinated network made by countless sensors that are conveyed haphazardly in checking provincial through remote correspondence [1]. With its wide application in military perception, therapeutic aide, strategies the board, natural noticing, cultivating and other business areas, Wireless Sensor Networks has transformed into the furthermost innovation in the field of correspondence and PC research. Sensor nodes rely upon battery power supply, their correspondence limit and energy battery limit are incredibly obliged thus how to utilize the energy of nodes capably, change the organization energy usage and extend the organization lifetime has transformed into a fundamental design objective for Wireless Sensor Networks [2].

WSN contains a battery worked sensor gadget with data taking care of and giving over parts. Sensor nodes can be used in a controlled circumstance, where review and observation are segregated or in an uncontrolled circumstance. In the last circumstance security for sensor nodes is extremely vital for an incredible degree. The cost lies on the boundaries like battery, memory size and so on The sensor nodes are a framework containing many nodes which redesign the nature of the framework. The sensor nodes do data taking care of and sense the circumstances where

Corresponding Author:- Dr. R.M. Dilip Charaan
Address:- Teaching Fellow, A.C.Tech, Anna University, Chennai-25.

they are set. These additionally change the data into electronic transmissions and these signs get sent over radio waves to the base station (BS). It is uneconomical to send the individual data simply to the base station as sensor nodes are energy bound. The nodes encompassing the base station (adjoining sensors) produce enormous measure of data [3]. In these sweeping frameworks, how much data made is epic for the base station. To conquer this issue, data is gathered at the nodes. Subsequently one among the node needs to gather all the data and send it to the base station. On the off chance that the organization region is tremendous, just a single node goes about as the Cluster Head (CH) it depletes the battery in couple of milliseconds. Along these lines, the organization can't be worked. To beat this issue, various routing protocols are proposed [4].

Low Energy Adaptive Clustering Hierarchy(LEACH)

LEACH is intended for remote sensor organization. The fundamental thought is to isolate network into various clusters, arbitrary choice of group head node, and different nodes join the cluster by the rule of closeness, and afterward structure a group. Inside the cluster nodes will send information to Cluster Head node, then, at that point, Cluster Head node can pack the information and ship off the Sink Node [5].

LEACH chooses Cluster Heads utilizing the technique of "round". Its activity is partitioned into two phases: the principal stage is laying out a cluster and the second stage is the steady information transmission. Every one of the nodes can be partitioned into a few clusters, and each group select a Cluster Head node arbitrarily. Created a arbitrary number somewhere in the range of 0 and 1, on the off chance that every node's arbitrary number is not exactly the specific edge T(n), then, at that point, the node turns into the Cluster Head nodes. The limit T(n) is characterized as beneath:

$$T(n)=\begin{cases}\dfrac{1}{1-p\left(r \bmod \dfrac{1}{p}\right)} & \forall n \in G \\ 0 & \text{otherwise}\end{cases}$$

where p is the percentage of cluster nodes in the network accounting for the total number of nodes; r is the number of completed rounds; G is a collection, the nodes of a collection is the nodes whose previous r rounds do not act as nodes of cluster nodes [6].

The Cons of LEACH Protocol

LEACH has great execution regarding energy utilization, however there are still inadequacies:

1) In the LEACH calculation, arbitrary determination of group head nodes can't ensure the uniform dispersion of the space, which prompts part of the group nodes can't join into any cluster part or individuals from the node, and the Cluster Head nodes consume an excess of energy during the information transmission.

2) Cluster Head node and Sink node take utilization of direct correspondence which cause the sensor far away from Sink node consume more energy [7].

3) Cluster Head choice doesn't consider the leftover energy of the nodes, which make the nodes with less lingering energy as the group head conceivable, for this situation, it can speed up the passing of the node, accordingly diminish the organization lifetime.

Energy effectiveness, adaptation to non-critical failure, versatility, node sending, inclusion, Quality of administration is viewed as the significant requirements in Wireless Sensor Networks. Methodologies acquired with the properties to give guard against the examined issues have been exhorted in [15]. One such strategy is the determination of a course through which information will be shipped off Base station for example direct transmission and multi-Hop transmission. In direct transmission, all the sensor nodes straightforwardly send their information to the Base station. However, in this approach, nodes which are exceptionally far away from the Base station consume more energy and in a roundabout way corrupt the presentation of the organization. In multi-bounce transmission, every node sends its information to that node which is close to the Base station which puts more loads on that specific node, consequently diminishing the life expectancy of the node and organization.[8]

The descendants of LEACH Protocol are discussed below,

A-LEACH

LEACH protocol accepts that a portion of the nodes in the organization which doesn't have a place with any of the group that is being shaped in the organization would move their detected information straightforwardly to the sink. This would cause high measure of traffic load adjusting at the sink and it likewise influences the energy productivity

factor. A-LEACH protocol ascertains the points among the nodes so that, the nodes would move the information to their separate CHs should misrepresents at a point not exactly or equivalent to 45° to the CH, it decreases the traffic. The points of the nodes to their separate CHs and the sink node is been determined by the spot result of the place of the nodes, CHs and the sink [9].

LEACH-B (Balanced Low Energy Adaptive Clustering Hierarchy)

In light of the investigation on the deformity in LEACH including the change of the quantity of Cluster Heads and the obliviousness of the node's lingering energy, this paper presents an original protocol called LEACH-B (LEACH-Balanced).At each round, after first determination of group head as indicated by LEACH protocol, a subsequent choice is acquainted with alter the quantity of group head regarding node's remaining energy. Accordingly the quantity of Cluster Head is consistent and close ideal per round.[10].

LEACH –C (LEACH- Centralized)

Wireless Sensor Networks (WSNs) are made out of small sensors nodes with restricted assets, and conveying together to screen the climate. Sensor nodes are generally fueled by battery. Therefore, the energy effectiveness is basic for the lifetime of the Wireless sensors organization. Directing protocols are the main issue for WSNs. LEACH (Low Energy Adaptive Clustering Hierarchy) is one of the first hierarchical routing algorithms for WSNs. LEACH-C (LEACH-Centralized) is a variation of LEACH where the Cluster Heads are chosen by the Sink. Toward the start of each round in LEACH-C, the sensor nodes should send data about their present energy to the Sink, which debilitates the sensor node battery. This paper proposes a better LEACH-C calculation in which, the Sink involves a utilization mode for every sensor node (CMSN) to gauge how much energy required for the following rounds; thus, sensor nodes doesn't need to send the worth of the current energy to the Sink toward the start of each round.[10]

CELL-LEACH

Wireless sensor networks have fueled battery sensor nodes which are utilized for communicating data over the climate screens. At this point energy effectiveness is the first issue in various remote sensor organizations. Therefore, different directing procedures have advanced, for example, to further develop life expectancy of the organization, to expand the most elevated dependability and furthermore to accomplish most prominent adaptability. On opposite side, WSN utilizes a typical various leveled clustering protocol called LEACH and it starts a standard calculation. The proposed calculation utilized is Cell-LEACH and which is explained as Cell Low Energy Adaptive Clustering Hierarchy. Various sensors are implicit with every one of the cell-heads. In this arrangement no reviewing and once again grouping is finished. Here, the cell head sends all information at a particular time by TDM. In this, Cell head performs collection of information and sends the handled information to group heads while it executes comparable capacity and moves information to base stations while it executes comparable capacity and moves information to base station.[11]

R-LEACH

To expand the lifetime of WSN the LEACH protocol is carried out by framing clusters for routing in an enormous scope organization. LEACH protocol uses the strategy of choosing the group head through arbitrary turns of a nearby cluster to disperse equitably the energy load among the remote sensor organization. In cluster correspondence circulated nodes communicate information clusters to its group head through moderate nodes. Under a limit energy level these nodes loses its energy and parcels get dropped. In the proposed framework a change in LEACH protocol to broaden the lifetime of whole organization and to keep away from the information misfortune an elective node is made to supplant the first. This expands the quantity of information clusters conveyed to the Base Station.[12]

ETH-LEACH

The working of ETH-LEACH is conceptualized in two sections. In the initial segment, TDMA is carried out to appraise the crafty ways to eliminate network upward. Moreover, in the subsequent section, an edge esteem is determined for picking the forwarder nodes. The proposed strategy limits the energy utilization of the sensor nodes and subsequently upgrades the organization's lifetime by broadening the term of node passing. The ETH-LEACH protocol is diverged from the various variations of LEACH to check its adequacy. The trial results show that the proposed ETH-LEACH protocol outflanks the customary routing protocols.[13]

EE-LEACH

An energy-efficient LEACH (EE-LEACH) Protocol for information gathering is presented. It offers an energy-proficient directing in WSN in light of the compelling information group and ideal clustering. In this framework, a Cluster Head is chosen for each groups to limit the energy dispersal of the sensor nodes and to streamline the asset usage. The energy-proficient directing can be acquired by nodes which have the most extreme remaining energy. Henceforth, the most noteworthy leftover energy nodes are chosen to advance the information to BS. It assists with furnishing better parcel conveyance proportion with lesser energy usage. The test results shows that the proposed EE-LEACH yields preferable execution over the current energy-adjusted routing protocol (EBRP) and LEACH Protocol concerning better parcel conveyance proportion, lesser start to finish deferral and energy utilization. It is clearly demonstrates that the proposed EE-LEACH can further develop the organization lifetime.[14]

Solar-Aware R-LEACH

The solar aware LEACH expands the lifetime of the sensor network by picking the nodes that are associated with the sunlight based charger. In the R-S-LEACH assuming the organizations are gathered into k clusters consequently k group heads are framed separately. In the main test, barely any nodes were associated with battery followed by the arrangement of clusters. In every single cycle, a battery controlled node was chosen as the Cluster Head. In the main case, 5 groups were framed and those clusters had a CH. These Cluster Heads (CH) were figured out how to have a sunlight based charger associated with it. Here the Cluster Head (CH) is found to have sufficient energy which is adequately adequate to go about as the following Cluster Head. Since the LEACH protocol has a condition that once the node is chosen it takes p rounds to turn into the following cluster. This protocol allows the opportunity for every one of the nodes to turn into the Cluster Head (CH) once for every single round. As the at first chosen CH is sun based fueled regardless of whether that specific node is taken advantage of it gets more than adequate measure of time to re-energize and gets outfitted to turn into the following cluster. Likewise these nodes were mustered to have nerve to run effectively for not many more adjusts. The non Cluster Heads (nCH) alone will disperse parcel of energy when exposed to transmission.[15]

LEACH-F (Fixed number of clusters)

Many directing protocols have been proposed to upgrade the proficiency of WSNs in the midst of previously mentioned extreme asset imperatives. Out of these, grouping calculations have acquired significance, in expanding the existence season of the WSN, due to their approach in group head determination and information accumulation. LEACH (distributed) is the primary clustering routing protocols which is demonstrated to be better contrasted with other such calculations.[16]

I-LEACH (Improved Low Energy Adaptive Clustering Hierarchy)

I-LEACH protocol serves two fundamental capacities in particular: Detection of Twin nodes and Assignment of Sub-CH (SCH) nodes. The two nodes which are near one another in the organization are called as Twin node. These sorts of node clearly would detect a similar data. In this manner it is important to keep one among the two twin nodes in rest mode, until the principal node runs out of energy. I - LEACH tends to the uniform circulation of CH in the organization with the goal that it doesn't run out of energy for longer distance transmission. I-LEACH likewise chooses sub-CH alongside CH in each groups, so that at whatever point the CH passes on inside the round then sub-CH keeps on being CH for that specific group for that round to guarantee no deficiency of information.[17]

K-LEACH

Energy saving is the urgent issue in planning the remote sensor organizations. In this paper, an adjusted calculation for Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is proposed. The altered protocol called "K medoids-LEACH protocol (K-LEACH) for clustered WSN" is pointed toward dragging out the lifetime of the sensor networks by adjusting the energy utilization of the nodes. The proposed protocol utilizes the k medoids clustering calculation for uniform grouping and Euclidean distance and most extreme leftover energy (MRE) is utilized to choose the group head (CH). The exhibition of K-LEACH with that of the LEACH protocol is thought about utilizing reproductions. Reproduction result shows that K-LEACH further develops the organization life expectancy over LEACH. Watchwords LEACH, Wireless sensor organization, Routing Collapse.[18]

M-LEACH (Multi-Hop Low Energy Adaptive Clustering Hierarchy)

In LEACH protocol the data is sent from CH to the BS through single bounce correspondence.

At the point when the organization size is expanded past a specific level, the distance between the CHs and the sink node may increment, which is one of the disservice of the LEACH protocol. Energy utilization will likewise be

more if distance is far. MultiHop-LEACH is a group based directing calculation in which self-chosen CHs gather information from all the sensor nodes in their group, total the gathered information by information combination strategies and send the information through an ideal way between the CH and the BS through other transitional CHs and utilize these CHs as a hand-off station to send information through them.[19]

Sleep LEACH

After the nodes get parted into gatherings or clusters, the nodes in each group will send their data in the specified time span individually and after every one of the nodes complete the process of sending data then the Cluster Head(CH) totals the information and then, at that point, sends to the Base Station (BS) .Similarly every one of the Cluster Heads play out something very similar. At long last, the Base Station (BS) will communicate the information. Here, the non Cluster Head (nCH) nodes communicate information just during their dispensed time span. So the nodes can be made to rest until their assigned time has shown up. In the event that this method is followed for communicating information, the nodes can moderate more energy.[15]

LEACH-MODRA and LEACH-THRA

The LEACH-RA is an excellent approach to keep the energy by omitting the unnecessary sensors. MODLEACH is a low-energy protocol that uses a cluster head replacement technique and has two transmitting power levels. This study introduces upgraded versions of LEACH-RA, such as LEACH-MODRA and LEACH-THRA. LEACH MODRA also has the capacity to transmit at two different power levels. The major goal of the LEACH-THRA protocol is to save energy consumption by preventing redundant data transmission based on the TEEN protocol's soft and hard thresholds..[20]

LEACH-M (Mobile Low Energy Adaptive Clustering Hierarchy)

LEACH thinks about all nodes as homogeneous and static, which is anything but a practical methodology. The LEACH-M is proposed to conquer the portability issue. During the arrangement and consistent state stage, LEACH-M gives versatility to the non-CH nodes alongside CH. The nodes area is given by GPS along the attributes of the nodes. The CHs are chosen based on least versatility of the node and most minimal lessening method of the node. After determination of CH, the situation with the CHs is being communicated inside its transmission range.[21]

Q-LEACH(Quadrant Based LEACH)

Various methodologies in view of clustering are proposed for ideal usefulness. Network life-time is generally related with energy of sensor nodes sent at distant regions for consistent and issue lenient monitoring. According to this approach sensor nodes are a conveyed in the area. To obtain better clustering we parcel the organization into four quadrants. Improving inclusion of the entirety network is accomplished. Moreover, definite conveyance of nodes in field is likewise distinct.[22]

LEACH-S (Solar-Aware Centralized LEACH)

The nodes in the LEACH depend on environmentally friendly power like battery, so in sunlight based mindful Centralized LEACH nodes are sun based mindful. In this protocol CH are chosen by BS with assistance of worked on focal control calculation. BS regularly select sunlight based controlled nodes, as these have greatest remaining energy. In sun powered mindful LEACH, nodes send their sun based status to base station alongside energy and nodes with higher energy are chosen as Cluster Head. The sun term expands the lifetime of the sensor organization. The CH handover takes place on the off chance that the sun span is more modest.[23]

SECURED LEACH

Because of the distant remote nature and human unattended climate of WSN, they are more powerless against different kinds of attacks might visit these organizations deliberately or unexpectedly. The calculations proposed to distinguish assuming any interloper is inside the organization and to recognize the wormhole and dark opening assaults. In this location method it attempts to forestall the assaults in LEACH protocol in a remote sensor networks utilizing the different base stations and key. Since, LEACH protocol is utilized the utilization of energy is likewise decreased to greatest degree. This thus diminishes the upward and information conveyance increments. As numerous base stations are utilized information gets conveyed penny percent. Since, LEACH protocol is utilized, it ensures power supply for a lot of time with additional energy. This guarantees that the parcel conveyance proportion has expanded drawing out the lifetime of the organization. The singular nodes are given greater security, adding security to nodes will consume more energy along these lines diminishing the lifetime of the organization. Assuming the nodes are sun oriented mindful, the energy level gets balanced and furthermore surplus energy might be acquired

on account of utilization of the LEACH protocol. The proposed protocols are made to identify and forestall the assaults accordingly controlling the upward, expanding clusters conveyed and broadening the lifetime of the remote sensor organizations.[24]

T-LEACH (Threshold LEACH)

In LEACH protocol, the CH gathers also, totals information from the sensor in its own group. The data is passed to the BS directly. The distance between the BS and the CH may be extremely high. In this way, the CH utilizes a large portion of its energy for transmission. This is on the grounds that the CH is generally in on mode and the CH will kick the bucket quicker than different nodes. In this protocol, CH gathers information from different clusters and functions as of the customary LEACH yet moves information straightforwardly to BS. It utilizes one of the CH's that is lying between the CH and the BS as a transfer station.[10]

V-LEACH (ViceCH LEACH)

In LEACH, the CH generally gets and communicates information to/from the cluster individuals. Along these lines, there are something else chances of CH to pass on sooner than different nodes in the cluster. Whenever the CH bite the dust, the cluster will become pointless since the information assembled by cluster nodes won't ever arrive at the base station. In VLEACH [21] is proposed with the point of decreasing the energy utilization inside the remote organization. In LEACH the group contains just CH also, nodes, however in VLEACH it incorporates bad habit CH alongside the CH and ordinary nodes. The V-CH will turn into a CH of the group on the off chance that the current CH bites the dust and thus there is no deficiency of information transmission to the BS, and furthermore keep away from the need of choosing another CH each time the CH kicks the bucket and subsequently expands the general organization time [25]

Table 1 shows a quick comparison of LEACH routing protocol descendants in terms of scalability, self-organization, and node distribution, network control, Hop count, energy efficiency, and utilization of location information. All of these hierarchical routing methods outperform the traditional LEACH routing.

Clustering routing protocol Decedents of LEACH	Scalability	Self organization	Work Distributed	BS Centralized Control	Hop count	Use of location information	Energy efficiency	Improvements over LEACH
A-LEACH Angled LEACH	Good	Yes	Yes	No	Single Hop	Yes	Very High	Every node in a network is affiliated to a one of the cluster in the network. In LEACH farther sends data directly to BS.
LEACH-B LEACH Balanced	Good	Yes	Yes	No	Single Hop	Yes	High	Communication between non-CH and CH is allowed and not among non-CH nodes. In LEACH distance between every pair of nodes is known.
R-LEACH	Good	Yes	Yes	No	Single Hop	Yes	High	Selection of CH and an alternate node.
LEACH-C LEACH Centralized	Good	Yes	Yes	No	Single Hop	Yes	High	Selection of CH nodes is done at BS and not among the nodes of each cluster as in LEACH
C-LEACH Cell LEACH	Very Good	Yes	Yes	No	Single Hop	Yes	Very High	Cell formation with in a cluster is done to transmit between CH to BS. In LEACH nodes send data to CH

								in turn transmit to BS.
LEACH-ET LEACH Energy Threshold	Very Good	Yes	Yes	No	Single Hop	Yes	Very High	Based on threshold energy the CH nodes continued to act as CH for next round. There is no threshold concept in LEACH
E-LEACH Enhanced LEACH	Good	Yes	No	No	Single Hop	Yes	Very high	Number of cluster is pre-determined in E-LEACH
R-S-LEACH	Good	Yes	Yes	No	Single Hop	Yes	Very High	Nodes are made solar aware in R-LEACH
LEACH-F LEACH Fixed	Limited	No	No	Yes	Single Hop	Yes	Very high	Number of Clusters and total number nodes (CH and non CH) are fixed
K-LEACH	Limited	Yes	Yes	No	Single Hop	Yes	Very High	Based on K-Mediods technique network is partitioned into clusters
I-LEACH Improved LEACH	Very Good	Yes	yes	No	Single Hop	Yes	Very High	Detection of Twin nodes (one among the two twin nodes in sleep mode, until the first node would run out of energy)and Assignment of Sub-CH nodes in addition to CH.
M-LEACH	Good	Yes	Yes	No	Multi Hop	Yes	High	Multi Hoping is made possible in the Wireless Sensor Networks
SLEEP LEACH	Good	Yes	Yes	No	Single-Hop	Yes	Very High	Idle nodes are made to Sleep to preserve more energy
LEACH-M LEACH Mobile	Very Good	Yes	Yes	No	Single Hop	Yes	High	Mobile nodes are considered where as in LEACH nodes are static.
Q-LEACH Quadrant LEACH	Limited	No	No	No	Single Hop	Yes	High	Network is partitioned into four sub quadrants and LEACH is applied to each quadrant
LEACH-S LEACH-Solar	Good	Yes	Yes	No	Single Hop	Yes	Very High	Nodes are made solar-aware
Secured LEACH	Good	Yes	Yes	No	Single Hop	Yes	High	Nodes are provided with security against Wormhole and Black hole attacks.
T-LEACH Threshold LEACH	Good	Yes	Yes	No	Single Hop	Yes	Very High	CH nodes continue to act as CH for next round if their energy is more than threshold
TL-LEACH Two Level LEACH	Very Good	Yes	Yes	No	Multi Hop	Yes	Very High	Assistant CH lie between CH and BS using multi Hop, but in LEACH transmission is single-Hop
V-LEACH Version LEACH	Very Good	Yes	Yes	No	Single Hop	Yes	Very High	Vice-CH is selected in addition to CH in each cluster, but in LEACH only CH node is selected.

Table.1:- Enhanced Descendants of LEACH Protocol.

Conclusion:-

Because the domains of multiple computing, new nanotechnology, and many current applications continue to advance at a rapid pace, such study remains an open topic. We have presented a portion of what is relevant to the various routing protocols in this study and attempted to demonstrate what improves the network's energy consumption.Due to the limited energy resources of sensors, one of the primary problems in the design of routing protocols for WSN is energy efficiency. The routing protocol was created with the ultimate goal of extending the network lifetime of WSN sensors. This paper provides an overview of the LEACH protocol and its enhanced descendants. According to the survey, establishing a far more efficient, scalable, and robust clustering technique for higher performance is still required for energy-efficient and long-lasting wireless sensor networks.

In future, a investigation on the function of Internet of Things based sensor networks in improving communication utilizing the LEACH protocol can be carried out. Especially in agriculture based Internet of Things. India's agriculture is the backbone of the country. Water shortages occur frequently depending on the season and location, particularly in tropical areas like Tamil Nadu[26]. Regardless of public perceptions of the agricultural process, the reality is that today's agriculture business is more data-driven, precise, and intelligent than ever before. The fast rise of Internet-of-Things (IoT) based technologies has altered nearly every business, including smart agriculture, which has shifted from statistical to quantitative methodologies[27].

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