Analysis on Energy Efficient Protocols-Wireless Sensor Networks

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Abstract:

Wireless Sensor Networks are among the networks which have the aptitude to be used in harsh surroundings. Wireless Sensor networks utilize micro sensor nodes. Although, sensors offer high quality and proficiency to put up with faults but their inadequate battery life is indulging it in impediments. Because limited battery life hinders communication among nodes in Network. Keeping in view above particulars; analysis has been completed on protocols that resolve crisis of low energy due to limited battery. This paper states analysis on Low Energy Adaptive Clustering Hierarchy protocol that has now decidedly shaped into Advanced Low Energy Adaptive Clustering Hierarchy protocol to put off energy dissipation in improved manner. This Review paper is intended for comparing Energy Trends in Low Energy Adaptive Clustering Hierarchy, Advanced Low Energy Adaptive Clustering Hierarchy, and Low Energy Adaptive Clustering Hierarchy –Clustering. It is static and has heterogeneous routing protocol, Multi Hop and Distributed Energy Efficient Clustering Protocol. How Leach protocols could be improved. Result has offered availability of low power sensors consisting of sensor nodes that use clustering practice. Outcome of this analysis illustrates that utilization of energy can be minimized in protocols by facilitating equal load allocation among all nodes.

Keywords: LEACH protocol; Wireless Sensor Network (WSN); Multi Hop (MHT); Base Station (BS); Cluster Head (CH); Distributed Energy Efficient Clustering (DEE); Medium Access Control (MAC).

1. Introduction

The Wireless Sensor Network (referred to as WSN from now) has become an advance trend of today's Networking era.

It is being used for past years for observing physical world communication. It is a particular type of ad hoc network that monitors substantial world by using undersized sensors. These sensors are hundreds or thousands in amount and are compactly or sparingly distributed in the network [1]-[2].

At the moment of Communication; application comprising sensor nodes have intentions to send gathered information by sensing target region [3]. After sensing target region, regular nodes launch their information to desired CH which is accountable for transferring information to the BS. The distinctive configuration of wireless protocol is illustrated in Fig.1 below.
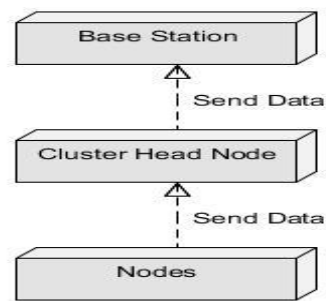
Fig. 1. Wireless Protocol Configuration.

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Battery is set with a sensor which supplies power to the nodes in the network. This battery fails because it couldn't offer countless power in network [4]-[5]. For this purpose, Low Energy Adaptive Clustering hierarchy (LEACH) [6] Protocols are designed which consume smaller amount of energy and consequently boost network life span. This LEACH has been further enhanced and affirmed earlier. This paper enlightens progressions that have been made in field of Wireless Sensor Network which put off energy loss and add to network lifespan and provides comparative study among Advanced LEACH (Ad-LEACH) [6] protocol, MH-LEACH (Multi-Hop LEACH) [7]-[8] protocol and DEEC (Distributed Energy Efficient Clustering) [9] protocol correspondingly.

This paper is alienated as follows: Section 2 portrays Literature Survey, Section 3 portrays Latest Energy Efficient Protocols, and Section 4 presents Comparison between LEACH, LEACH-C, Ad-LEACH and Multi Hop and DEEC. Section 5 portrays conclusion which wrap up this Paper.

2. Literature Survey Of Traditional Energy Efficient Protocols

WSN has made today's communication cost effective, simple and easy. WSN supports heterogeneous applications [10]. But the problem that made WSN unreliable is short lifetime of its battery [11, 12]. There are many protocols that had been implemented in WSN but these traditional protocols were not able to optimize

1) Direct Communication
2) Minimum Transmission Energy
3) Multi-hop Routing
4) Static Clustering.

Every Protocol intended to resolve setbacks for WSN have been conferred underneath one by one.

A. LEACH and its limitations

Some students of Massachusetts Institute of Technology (MIT) took into account all these above mentioned problems and introduced a new protocol, called Low Energy Adaptive Clustering Hierarchy (LEACH) [13].

LEACH is presented in 2000 [13]. LEACH protocol consists of subsequent characteristics conversed below.

1) It is clustering based protocol. Clusters consist of nodes; these nodes acquire data from each node and hence fusing data to the cluster head by sending meaningful set of information from the nodes. Each CH broadcasts data to BS. Configuration of LEACH is the same as Simple Wireless Structure shown in fig. 1 [13-16].
2) It allocates Energy to the sensors of cluster head. LEACH is able to distribute energy dissipation evenly throughout the sensors that double the useful system lifetime, for the network [13-17].

A leach is able to solve most of the problems faced by traditional protocols. But there were flaws in LEACH itself that are`

1) Nodes can only send data to their cluster head which makes more likelihood for CH's to die quickly. Hence life-span of Network is minimized.
2) Nodes cannot communicate among each other. If a sensor is not a cluster head, afterward it cannot launch data to further sensors. Consequently, distance among nodes turn out to be larger which in outcome shortens energy level of entire Network

Above particulars make it obvious that network protocols which extend battery life are more purposeful. So, these flaws were eliminated by introducing two more advanced protocols Multi-Hop Low Energy Adaptive Clustering Hierarchy (MH-LEACH) and Advanced LEACH which are conversed in Section 3.

B. LEACH-C

LEACH-C is presented in 2002. LEACH-C (Low Energy Adaptive Clustering Hierarchy Centralized) uses clustering Centralized Technique for assembling clusters as discussed. Clusters assembly in LEACH-C

has CHs whose initiative is to execute subsequent roles [18-23].

1) CH's are there to determine locality and energy intensity of each node that is accountable for conveying information.

2) CHs send Meaningful Data to Base Station. LEACH-C executes tasks in Rounds. In every Round, BS ensures by estimating the average energy that energy is circulated uniformly amongst each node in WSN network [23].

In Centralized technique, Central unit has all the data collected from different nodes. Central network performs its responsibility for estimating each nodes position in network; whereas, in distributed technique, there are estimations of each node instead of having central unit and as a result, location is estimated grounded on local data collected from its adjacent nodes. The likelihood of bottleneck increases in centralized algorithm as connection of node can be lost if an error occurs or a critical node expires, whereas in distributed technique failure of one node doesn't affect system decisively [24]. Consequently distributed technique is more vigorous than Centralized Technique.

C. Ad-LEACH

Ad-LEACH (Advanced Leach Energy Efficient protocol) is presented in 2008 [25]. It has Static Clustering approach. BS position and arrangement of clusters of whole Network is predefined. After deciding Cluster Head, TDMA serves in data transmission as discussed below.

1) *Cluster arrangement*

Low Energy Adaptive clustering hierarchy launch network in form of static and unending clusters. In Ad-LEACH Square and Rectangular could be the shape of clusters according to the necessity and region offered. The review we carried illustrates both shape clusters.

Adjacent clusters would have segregated protocols in each cluster. For lessen complication and power dissipation, motivation is in separating entire region into little static fields. Organizing immense field of operation is more difficult than clusters covering small portions. Therefore, Outcome of clusters formation lowers power intensity of their messages being transmitted [25]-[29].

2) *Cluster Head Decision*

After Cluster formation, it's time to decide cluster head because each cluster has separate Ad-LEACH protocols. CHs are selected on the basis of left over energy they contain while being in clusters. Nodes in network need prerequisite awareness of its entire energy and life-time of network in WSN. Networks entire power is transmitted from BS to each node in DEEC.

$$T(n) = \begin{cases} \dfrac{P_d}{1 - P_d * \left((r) \bmod \dfrac{1}{P_d}\right)} & \text{if } n \in A \\ 0 & \text{Otherwise} \end{cases}$$

(1)

The CH is chosen at every single round with the assistance of formula (1). The Threshold T (n) is generated by putting Percentage as 5% and A is nodes other than chosen CH's [5, eq (1)]. In the manner CH is elected, the elected cluster head must inform each node regarding its existence in clusters. CH and remaining nodes use Carrier Sense Multiple Access (CSMA), which is the protocol of MAC in the network.

3) *Client Scheduling*

Client information is received by CH from each node in cluster by building TDMA (Time division Multiple Access) schedule. Schedule is formed for all of its nodes which are used for data distribution towards Cluster Head (CH) Node.

4) *Data Transmission*

After building TDMA, broadcasting of data can take place. CH can be approached by its client nodes in only allocated time period. For the duration of Unallocated Time Period, client nodes are required to turn their radio off

for avoiding energy dissipation. Broadcasting energy level is based on (Received Signal Strength) RSS which is principally selected by every node itself. As there is load on CH, there is a possibility that CH might fail. CH Rotating is suggested in Ad-LEACH so that CH lifespan can't be endangered [29].

The difference between LEACH and ALEACH (Advanced low Energy Adaptive clustering hierarchy) is that in ALEACH network carry out broadcasting messages in rounds and elects CHs rather than identifying environmental position of each node. Then Multi-Hop Routing, DEEC is proposed in 2011 [30]-[31], 2014 [32], which is an expansion of above LEACH protocols which is discussed in this paper in section 3.

3. Latest Energy Efficient Protocols

A. Multi-Hop

In [4], Multi-Hop Communication is offered which is a new method of clustering. MH-LEACH have cluster Heads whose essential reason is to keep energy and which as outcome add to network life span. Energy dissipation is one of the most important aspects of MH-LEACH.

The algorithm implemented in MH-LEACH that transfers data to farthest location using lowest possible energy because in this protocol, a node sends data to its nearest node resulting in lower consumption and that makes a network reliable. In this algorithm, a sensor sends data to the base station only when it has received the data completely. In this protocol, sensors remain dormant when data is not being sent or received.MH-LEACH decides CHs in similar technique as LEACH protocol [31].There are two manners in which communication is performed in Multi-Hop.

1) *Inter Cluster Transmission*

Inter Cluster Transmission is the type of Transmission which transmits information by gathering data. Clusters have CHs which obtain data from nodes and aggregate information for transferring the concluded information to BS.

2) *Intra Cluster Transmission*

Inter Cluster Transmission is the type of Transmission which transmits information by gathering data from all member of nodes. There are two phases of MH-LEACH:

Phase 1: In first phase, cluster-headers are defined as a part of LEACH protocol. Then they make an announcement and all the cluster headers construct their routing table taking in account the level of signal received.

Phase 2: When the cluster header sends data, according to the routing table previously constructed, the base station checks whether the cluster head is not clashing with other routes. After checking this condition, base station sends data to another node.

Multi Hop Transmission makes clusters in Intra Communication which approaches CHs by transmitting data after gathering it from other member's nodes. It follows the same mechanism as LEACH does by executing tasks in Rounds. It fundamentally decides pathway that have minimum hops among CHs and Base Station (BS) [31].

B. DEEC

In WSN, Distributed energy efficient clustering algorithm (DEEC) is presented. DEEC reflect on attributes which are Heterogeneous [32]. DEEC algorithm progress scalability and decrease amount of battery utilization. Consequently, the Algorithm of choosing CH is pursued of DEEC in Ad-LEACH [33]-[34].

4. Comparison Between Traditional And Latest Energy Efficient Protocols On The Basis Of Their Properties

A. Protocol Properties discussion

Comparison of network design for Protocols on the basis of properties is prepared in this Section by keeping in view analysis of LEACH and other Latest Energy Efficient protocols already discussed in previous sections. The properties of protocols which are stated in the Table 1 are described underneath one by one.

1) *Life span of Network*

Lifespan is the characteristic which tells the duration of nodes that are alive and dead in the network.

2) *Energy Usage*

Energy Usage is the characteristic of WSN which determines the usage of energy while sending data from CH to BS.

3) *Scalability*

Scalability determines the amount of data that can be sent without any failure of nodes.

4) *Transmission of packets*

Packet Transmission rate is analyzed of the network.

5) *Pathway Choice*

Nodes select whether the path would be Single Hop or Multi Hop. In Single Hop Routing, nodes send data to Cluster Heads. CH's sends data to Base Station directly. In Multi-Hop Routing, nodes send data to Cluster Heads. CH's send data to nearest CH's and thus shorten the distance towards BS.

6) Amount of active nodes

Nodes chosen as CH have greater probability to die soon. This property analyzes the Active Nodes and Dead Nodes measurement.

7) Classification

Classification is made on the basis of Hierarchal clustering. In Hierarchical Clustering, there are many clusters in entire network. Clusters have Cluster Heads. CH's are there to determine locality and energy intensity of each node that is accountable for conveying information. CHs send Meaningful Data to Base Station.

8) *Position Awareness*

The location is found of network in some protocols so that data can be gathered.

9) *Mobility*

Mobility determines base station kind which varies from fixed Base Station to changing Base Station. Normal Nodes send data to chosen CH. Then chosen CH's send useful information to BS.

10) *Data Aggregation*

Data Aggregation utilizes aggregating algorithm. The algorithm used for this intention is Centralized Algorithm. It is the process in which information is divided into packets to send consequential information to the BS in the network.

B. Results

TABLE 1. Comparison between Diverse Routing Protocol on basis of their Properties.

S. No.	Protocol Properties/Reference	Routing Protocols in Wireless Sensor Network				
		Leach	*Leach-C*	*Ad-Leach*	*Multi-Hop*	*DEEC*
1.	Lifespan of Network/[2]	Great	Greater than Leach	Greatest as CH rotates	Improved than Leach	Improved
2.	Energy Usage/[35]	High	Unit Energy Less than Leach	More than LEACH	Reliable	Reliable
3.	Scalability/[2]	Inadequate	Inadequate/Very short	More than Leach	Adequate	Adequate/Enhanced

4.	Transmission of Packets/[35]	fewer	Extra Data for every Unit Time	More than Leach	More than Leach	More than Leach
5.	Pathway Choice/[2]	Single Hop	Single Hop	Single Hop	Multi-Hop	Multi-Hop
6.	Amount of Active Nodes/[35]	Identical	Nodes Die Earlier	Less Nodes Die	less but exploit more time to fail	More time to fail
7.	Classification/[35]	Proactive/ Hierarchical Clustering	Hierarchical Clustering	Hierarchical Clustering	Hierarchical Clustering	Proactive or Hierarchical Clustering
8.	Position Awareness/[2]	No	Yes	Yes	Yes	No
9.	Mobility/[2]	Unchanging Base Station	Unchanging Base Station	Unchanging BS	Change BS	Unchanging Base Station
10.	Data Aggregation/[35]	Yes	Yes	Yes	Yes	Yes

5. Conclusion

In WSN, Great piece of Research is being carried out with the intention to emphasize ways for sensor to save energy so that network life can be extended. Wireless Sensor Networks (WSN) set up ad hoc networks. Ad hoc networks agree to observing physical world through assistance of small sensors, which are sparingly or heavily distributed. Thus, DEEC and Multi-Hop protocol has the ability to be used in different applications. These protocols usage can consequence in controlling Energy Dissipation and progressing Networks Life Span which can become the basis of efficient Transmission in WSN networks. Review completed in this paper offers improved performance along with eradication of energy dissipation.

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