Comparative Study of LEACH and It's Variants

Sugandh[#], Prof. Rakesh Panday[*]

[#]*Department of Computer Science & Engineering, OIST, RGPV University, INDIA*

**Assistant Professor, Department of Computer Science & Engineering, OIST, RGPV University, INDIA*

Abstract - Mobile Adhoc Networks are restricted in terms of energy resources and thus need efficient energy management throughout the collection, dispensation, aggregation and communication. Energy efficiency is the important concern in Adhoc networks. Thus, to maximize network lifespan and accomplish maximum dependability and scalability, routing methods have been developed. LEACH is the conservative hierarchical clustering protocol that is broadly utilized in wireless adhoc network. All the nodes in the MANET are equipped with battery and thus the main aim to improve the energy that is used to transmit the message from one node to another.

Keywords: LEACH, Cluster, Energy Efficient, Routing Protocol, MANET.

I. INTRODUCTION

A MANET consists of tiny mobile nodes. The network must possess self-configuration capabilities as the positions of the individual sensor nodes are not predetermined.

Routing strategies and security issues are a great research challenge now days in MANET but in this paper we will emphasize on the routing protocol. A number of routing protocols have been proposed for MANET but the most well-known are hierarchical protocols like LEACH [1] and PEGASIS [2].

Hierarchical protocols are defined to reduce energy consumption by aggregating data and to reduce the transmissions to the Base Station. LEACH is taken as a very famous routing protocol which implements cluster depended routing for reducing energy consumption.

In this paper firstly we analyze LEACH protocol and then in the third section we will discuss the phases of LEACH protocol. In the fourth section we define various possible attacks on it and in the fifth section there are the advantages and disadvantages of LEACH. In the last section we compare LEACH with other protocols.

2. ROUTING PROTOCOLS AND ENERGY EFFICIENCY IN AD-HOC NETWORKS

A mobile Ad-Hoc network is a co-operative network of wireless nodes that communicate over a wireless medium. Topology changes of the wireless nodes in the network are rapid, and these networks are self-configuring in nature requiring de-centralized control and administration. Such networks do not surmise all the nodes to be in the directly transmission range of one other. Therefore, these networks needs highly specialized routing protocols that significantly contribute self-starting behavior. Energy constrained nodes, low channel bandwidth, node mobility, high channel error rates, and channel variabilityare few of its limitations in an Ad-Hoc network. Under these conditions, existing wired network routing protocols would fail or perform poorly. Thus, Ad-Hoc networks necessitate special routing protocols. Ad Hoc routing protocols are conveniently categorized based on the way route tables are constructed, maintained, and updated [3]. Fig.1 shows the broad classification of MANET routing protocols.

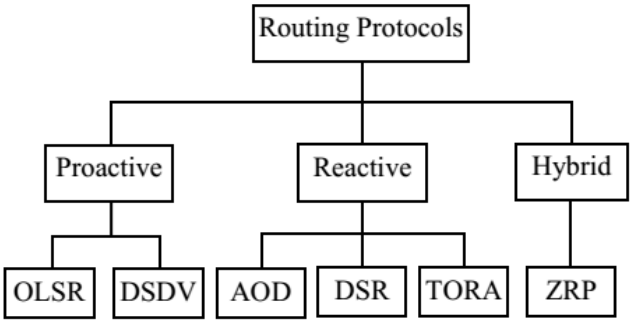

Figure 1 Classification of Routing protocols

The concept of hierarchical routing is to perform energy-efficient routing in MANETs and hence prolong the network lifetime [4][5]. Creation of clusters and assigning tasks to cluster heads can contribute to overall system scalability, lifetime, and energy efficiency. Hierarchical routing is an efficient way to lower energy consumption within a cluster, performing data aggregation and fusion in order to decrease the number of transmitted messages to the BS. Hierarchical routing is mainly two-layer routing where one layer is used to select cluster heads and the other for routing.

3. VARIANTS OF LEACH

3.1Threshold sensitive Energy Efficient sensor Network protocol (TEEN)

It is a hierarchical protocol with the implementation of a data-centric mechanism and is compactable for time critical data sensing applications in terms of energy consumption and response time. It is reactive to quick changes in its sensed features. In the sensor network architecture nearest nodes form its clusters and this

approach proceed towards second level till base station isn't reached. The time clusters are produced, the CH telecast two thresholds to their nodes. Which are hard and soft thresholds for the sensed attributes. Hard threshold refer as the minimum possible value. The soft threshold can be varied, depending on the target application. A smaller value of the soft threshold gives a more accurate picture of thework but energy consumption increases. Thus there is a trade-off between energy efficiency and accuracy. The drawback of this scheme is the complexity of forming clusters in multiple levels. Moreover, TEEN only transmits time-critical data while sensing the environment continuously and the nodes will never communicate if the thresholds are not reached[6,7]. Tile line is shown in figure 2.

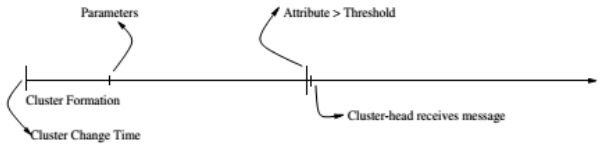

Figure 2: *Time Line for TEEN*

3.2 Adaptive Threshold sensitive Energy Efficient sensor Network protocol (APTEEN)

It is anmodification of TEEN and motives at capturing periodic data collections and getting towards time critical events too. CHs also perform data aggregation in order to save energy. The nodes in such a network gives anwhole picture of its network at a periodic intervals proceed in aenergy efficient manner. That kind of network permits the user to demand past, present and future data from their network. The performance level of APTEEN takes place in between TEEN and LEACH regarding the energy consumption and lifetime of the network. The drawbacks of TEEN can be overcome using APTEEN which uses periodic data transmission. APTEEN transmits data, based on the threshold values unlike LEACH which transmits data at all times. But this energy saving increases the response time[7, 8].

3.3 Power-Efficient Gathering in Sensor Information Systems (PEGASIS)

It is a chain-based protocol and is an improvement over LEACH protocol. In this protocol each node communicates only with its closer neighbor. The data which moves from one node to another node, aggregates and send to the base station. In contrast to LEACH, only one node is used to transmit data to the base station instead of using multiple nodes. Hence it extends the network lifetime by using collaborative techniques. Moreover, bandwidth consumed in communication is reduced as there is only local coordination between closer nodes. PEGASIS has been shown to outperform LEACH by about 100–200% for different network sizes and topologies. It is due reduction in the number of transmissions and receptions using data aggregation as well as due to the elimination of overhead caused by dynamic cluster formation in LEACH. However, it results in excessive delay for distant node on the chain [7, 9]. Chain construction is done by greedy approach and it shown in figure 3.

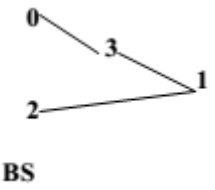

Figure 3: Chain construction using the greedy algorithm.

3.4 Hybrid Energy-Efficient Distributed clustering HEED (Hybrid Energy-Efficient Distributed clustering)

This is a stand-alone distributed clustering protocol that periodically selects CH by only considering communication distance and the node residual energy. Thus, a node with high residual energy has a higher chance to become a CH. HEED terminates the clustering process within a constant number of iterations, incurs low message overhead,and obtains fairly uniform CH distribution across the network. But, it does not guarantee the number of selected CH. If the energy of all nodes is similarly low, most nodes can become CH[10].HEED outperforms LEACH in terms of prolonging network lifetime by distributing energy consumption for a large network[7].

3.5 Density based Cluster Head Selection

This is a subtractive clustering technique. It overcomes the shortcomings of basic LEACH protocol in handling node's non-uniform and time variant energy distribution. In this algorithm the sensor node with the highest probability is taken up as the first cluster center and eliminates all nearby sensor nodes to determine the next probable cluster and its center location. This process continues until all sensor nodes are covered. A CH performs data aggregation and monitors inter as well as intra-cluster transmission of data in the network. A multi-layer selection criteria is considered for the selection of CH. The first level is the Energy Filtration. It checks the energy level of all the nodes in dominating set (DS). The next level is based on Node Connectivity via single hopping. The third level is based on considering the node identity. Initially nodes are provided a unique identity (ID), which is basically a number. Lowest identity (LID) is simple algorithm that selects a node with its ID lowest among the remaining nodes in the given set . In third level LID is considered only for the first round of CH selection. In LEACH, the CHs are elected randomly, so the optimal number and distribution of CHs cannot be ensured. The nodes with low

residual energy have the same priority to be a CH as the node with high residual energy, resulting in some node with low residual energy may die first. Hence in this new approach , the phenomenon of aging is used as the load balancing parameter for selecting CH. Once, a node from IDS becomes a CH, its probability to get re-elected as CH reduces. Therefore proper load distribution within clusters increases the lifespan of the sensor network[11].

3.6 LEACH protocol using Fuzzy Logic (LEACHFL)

This protocol takes three variables battery level, distance and node density into consideration. As LEACH only depends on probability model, some CHs may be very close to each other and can be located in the edge of the MANET. These in-efficient CHs could not maximize energy efficiency. A CH election method using fuzzy logic has been introduced to overcome the defects of LEACH. In this the network lifetime can be efficiently prolonged by using fuzzy variables : concentration , energy and centrality. In this approach a part of energy is spent to get the data of the three variables especially concentration and centrality[12].

4. RELATED WORK

Several researchers have evaluated and presented comparative analysis of MANET Routing protocols. Several conclusions have been drawn by evaluating the performance of routing protocols. Paper [13] provided a brief introduction of routing challenges and some design issues in MANETs. This paper also provided the comparative analysis of various routing protocols along with the most energy efficient protocol (LEACH) along some of the improve versions of it. Paper [11] surveyed the different hierarchicalrouting protocols derived from LEACH. This paper highlighted issues and drawbacks of LEACH and discussed a comparative study of features and performance issues of all hierarchical protocols.

Paper [14] presented a brief survey of Cluster-Based Hierarchical routing protocols that how protocols organize nodes into clusters. A comparison among clustering protocols taking features such as their transmission mode and selection algorithms for CHs has been carried out. Paper [15] provided the comparative analysis of LEACH and its descendants based on metrics like mobility, reliability and hop count. Paper [9] presented taxonomy of energy efficient clustering algorithms in MANETs and also presented the timeline and description of LEACH and its descendants. Paper [16] surveyed different hierarchical protocols developed from LEACH along with their pros and cons.

Hierarchical clustering algorithm, as shown in figure 4 [17],known as Low Energy Adaptive Clustering Hierarchy (LEACH) [7]. LEACH is a cluster-based protocol, which includes distributed cluster formation. LEACH randomly picks a somesensor nodes like cluster heads (CHs) and circulates this role towards distribute the energy load within the sensors in its network. In LEACH, the CH nodes suppress data reaching from nodes which relates with respective cluster, and transfer an aggregated packet to their BS in amanner to decrease the amount of information which have to be send to the BS. LEACH uses a TDMA/code-division multiple access (CDMA) MAC to reduce intercluster and intra-cluster collisions. Data collection is centralized and performed periodically. Therefore, this protocol is most appropriate when there is a need for constant monitoring by the sensor network.

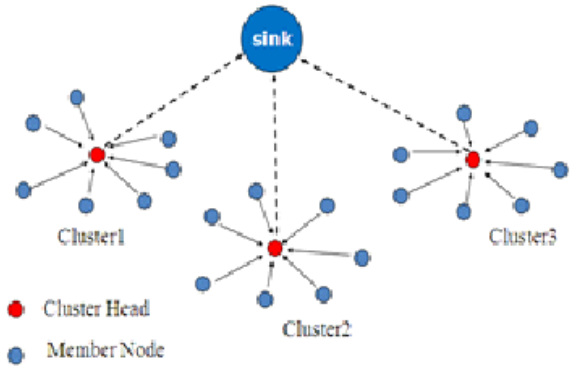

Figure 4: Cluster structure in Ad-hoc Network [17]

5. CONCLUSION

Competentlyusage of energy in the network has been the chiefmatter in MANETs for extendinglifespan of the network. LEACH has established one of the greatest energy proficient protocols usingMANET. Here in survey, LEACH protocol has been deliberated with its various disadvantages and how these disadvantages are overwhelmed by its offspring. A short-term study of severalbetterforms of LEACH protocol has been finished in instruction to matchroutine of these issues with the standard LEACH.

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