Comparative Study of Existing Hierarchical Based Routing Protocols for WSN

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Abstract—Wireless sensor network is a type of Ad hoc network but routing protocols for WSN are different from MANET because the factors like power, communication type, node deployment etc. are different in both. WSN protocols are classified on different parameters like Network Structure and Protocol Operation. On the basis of network structure there are three types of routing protocol flat routing, hierarchical routing, and location based routing. Flat routing protocols uses flooding and hierarchical routing protocol worked base on clusters resulting hierarchical protocols are energy efficient and easily scalable. The main aim of this paper is to evaluate, analyze and compare four existing hierarchical based routing protocols named Low Energy Adaptive Clustering Hierarchy (LEACH), Threshold Sensitive Energy Efficient Sensor Network (TEEN), Adaptive Threshold Sensitive Energy Efficient Sensor Network (APTEEN), and Distance Adaptive Threshold Sensitive Energy Efficient Sensor Network (DAPTEEN).

Keywords—WSN, MANET, LEACH, TEEN, APTEEN, DAPTEEN

I. INTRODUCTION

Wireless sensor network is an infrastructure less, random deployment of sensor nodes that cooperatively perform sensing information and process it with the help of a gateway or sink node via any medium like internet to end user shown in Fig1. Sensor nodes are mobile in nature and have limited capacity in terms of energy, storage, coverage area etc. [1].
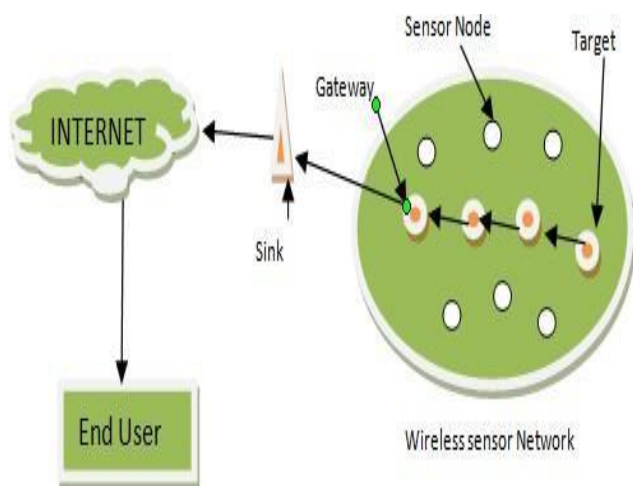

Figure 1: Wireless Sensor Network

On the basis mode of operation sensor nodes are classified in two categories first one is proactive and second is reactive. In proactive nodes are periodically active their sensors for sensing at regular gaps but reactive networks are active when a drastic change occurs [2].

In current decade too many research are taking place to improve energy efficiency, coverage area, capacity and efficient Routing etc. in WSN. In the last few years WSN has supported a variety of applications to satisfy needs of human life, different applications need different mechanisms for routing. Routing is a vast area for research in WSN, lots of work done in this area but still needs to work in this area. At present no clear classification for Routing protocol but it can be classified on the basis of network structure and protocol operation. Flat network, hierarchical and location based routing are types of network structure based routing [3]. all the sensor nodes perform similar job in flat routing, hierarchical routing is energy efficient in comparison than flat routing because nodes are divided in several clusters and each cluster have a master node and remains slave node, master node collects data from all nodes in the cluster and forward data to base station this scheme resulting decrease in traffic load of WSN and location based routing scheme is useful for location based applications or position based application that use in WSN [3] . In this paper main focus is on study and comparison of hierarchical routing protocols [4]. Section I tells about description about WSN and routing types, section II contains description about existing hierarchical routing protocol i.e. LEACH, TEEN, APTEEN, and DAPTEEN, section III contains comparison between discussed protocol and section IV is conclusion.

II. EXISTING HIERARCHICAL BASED ROUTING PROTOCOLS

Hierarchical routing is also known as cluster based routing in this routing scheme sensor nodes are divided in several

clusters and each cluster has a cluster head, all nodes within the cluster communicate to cluster head and cluster head communicates to the base station. This scheme has several benefits like energy efficient, and efficient utilization of resources because cluster head take responsibilities of all existing nodes in respective cluster [5]
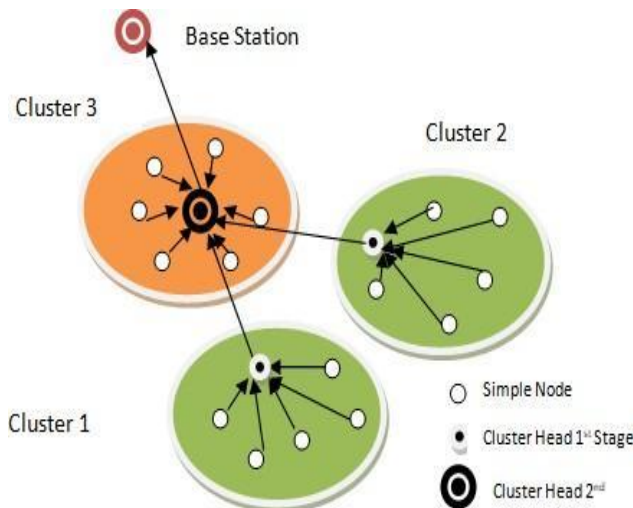

Figure 2: Hierarchical Routing Scheme

A. Low Energy Adaptive Clustering Hierarchy (LEACH) [6]

LEACH [6] is a first proactive hierarchical based routing protocol. After formation of cluster and election of cluster head it broadcasts a schedule for the rest of the nodes in the cluster for transmission of their data. According to the received schedule each node has its own transmission time and time taken for transmission by all the nodes is called one schedule time or frame time. Schedule repeats itself after completion one schedule time [2]. In this protocol cluster head chose randomly for making network energy efficient, increased life time, reduced data fusion whereas it is not suitable for large networks because it also uses hop to hop communication and more traffic for frequent choosing cluster head each time[7].
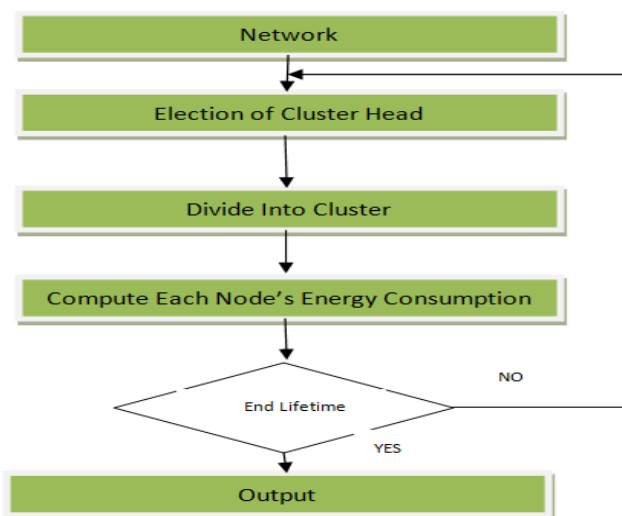

Figure 3: LEACH Protocol Flow Chart

B. Threshold Sensitive Energy Efficient Sensor Network (TEEN) [2]

TEEN [2] is reactive hierarchical based routing protocol. There are two parameters that cluster head broadcast when clusters change time. These two parameters are hard and soft threshold, lower bound of data transmission is hard threshold and change range of data detected is soft threshold. Sensed values are stored in a variable of a node internally and next transmit data if and only if sensed value is greater than hard threshold and difference between current value of sensed attribute and sensed value is equal or greater than soft threshold. This scheme is useful for time bounded sensing applications, energy efficient by less frequent data transmission. Main setback of this scheme is no data received until or unless threshold is not reached and not suited for periodic sensing applications [2].

C. Adaptive Threshold Sensitive Energy Efficient Sensor Network (APTEEN) [8]

APTEEN [8] is also a reactive hierarchical based protocol; it is a hybrid of LEACH AND TEEN protocol. APTEEN and TEEN have the same network structure planning. APTEEN is a better version of TEEN as it beats its inefficiencies and moves for getting held on both intermittent information accumulations (LEACH) and responding to time discriminating occasions (TEEN). Thereafter, APTEEN is a hybrid collection built directing convention. APTEEN allows the sensor to send their observed information alternatively and reply to some unexpected changes in the approximation of the sensed property by presenting the relating qualities to their Cluster Heads [9].

D. Distance Adaptive Threshold Sensitive Energy Efficient Sensor Network (DAPTEEN) [9]

This scheme's main aim is to reduce redundancy and improve energy efficiency. In DAPTEEN [9] when node perform sensing operation then firstly perform calculation of distance between each pair of node in their cluster, a assumption is that the nearer node collects same data in the cluster therefore only one node send data to cluster head, by this data redundancy reduced whereas energy efficiency improve. In fig 4 cluster have 5 nodes, 1 is cluster head distance between 1 and 1.1 is 3, 1.1 and 1.2 is 5, 1.2 and 1.3 is 3, 1 and 1.3 is 7, 1.3 and 1.4 is 5, 1 and 1.5 is 4. Let us suppose when the distance between two nodes is 2 then it can be said closer. So when 1.1 and 1.2 sense data then only one node processes its data and resulting redundancy is reduced [9].
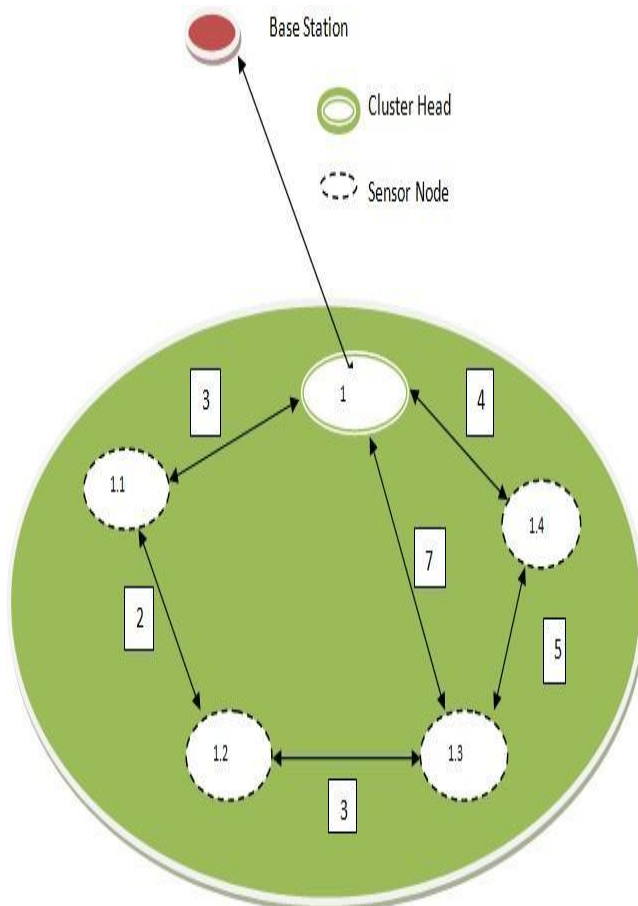
Figure 4: Data processing in DAPTEEN

III. COMPARISON BETWEEN HIERARCHICAL ROUTING PROTOCOLS

In current years there are many new features required to add in Routing Protocols for WSN like:

- Energy is a prime attribute when we design any protocol for WSN because nodes have limited power and no option available to replace batteries of nodes, so energy is a key attribute for extending network lifetime.
- Scalability is also an attribute that tells about the possibility of network expansion i.e. addition or deletion of nodes in a network.
- Data- based, minimize data transmission, reduce information redundancy through data fusion
- Robustness simply means fault tolerance i.e. if any node failure in network then routing must not be affected.
- Routing algorithms should be simple and easy to adapt.
- Overhead of nodes in a network should be least to make an energy efficient network.

All the discussed protocols are based on hierarchical routing schemes for wireless sensor networks, it is hard to say which one is superior to others. Table I shows comparison among discussed protocol on the basis of some attribute related to performance.

Table 1: Comparison Between Discussed Routing Protocols [7] [8] [9]

	LEACH	TEEN	APTEEN	DAPTEEN
CLASSIFICATION	Hierarchical	Hierarchical	Hierarchical	Hierarchical
ROUTE SELECTION	Proactive	Reactive	Reactive	Reactive
DATA AGREEGATION	Yes	Yes	Yes	Yes
NETWORK LIFE TIME	Good	Very Good	Poor	Excellent
ENERGY CONSERVATION	Very Good	Good	Good	Good
SCALABILITY	Good	Good	Good	Good
ROBUSTNESS	Good	Good	Good	Good
DATA BASED	No	Yes	Yes	Yes
OVERHEAD	Low	High	High	Very low

IV. CONCLUSION

The comparison shows that DAPTEEN is superior among all the discussed protocols; we can say that DAPTEEN is the second generation of TEEN protocol and APTEEN is the first generation of TEEN protocol. TEEN performs better than LEACH in most of the attributes and APTEEN removes some deficiencies of TEEN, DAPTEEN is superior to All discussed protocol in terms of energy efficiency, overhead, reduced data redundancy etc.

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