Comparative Study of Cluster Based Routing Protocol in Wireless Sensor Network

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***Abstract*- A WSN involves an ordinarily enormous number of sensor center points, in like manner called bits, passed on in the application circumstance. Bits are equipped with the specific sensors mentioned by the application, and gather information about nature, which is transmitted towards no less than one sink centers (in like manner called base stations). The aim of this research paper is the implementation of simulation models and the simulation of energy-efficient network initialization algorithms. First of all, it is presented a survey of state-of-the-art strategies for network initialization and exploration in wireless ad-hoc networks. Among the routing approaches presented in the survey it has been chosen the clustering-based approach due to it is the most suitable for ad-hoc sensor networks. Following are explained the features and properties of the clustering-based routing algorithms that have been selected for their implementation on this work. These implemented routing protocols are LEACH, TEEN, MODTEEN and APTEEN. On the other hand, all these routing protocols have been implemented and simulated using MATLAB Subsequently, all the protocols have been simulated with different parameters like Number of CHs, Number of Alive Nodes, Number of Dead Nodes, Number of packets to BS, packets to CH and conditions to prove their functionality and to find out their behavior in different sorts of sensor networks.**

***Index terms*- LEACH, TEEN, APTEEN, MODTEEN, CH**

I.INTRODUCTION

Wireless Sensor Network or WSN is gathered to be made up of a huge number of sensors and at least one base station [1]. The sensors are independent little devices with a few imperatives just like the battery control, computation capacity, communication range and memory. They moreover are provided with transceivers to assemble information from its environment and pass it on up to a certain base station, where the measured parameters can be put away and accessible for the conclusion user. In most cases, the sensors shaping these systems are sent arbitrarily and left unattended to and are anticipated to perform their mission legitimately and productively [5]. As a result of this arbitrary arrangement, the WSN has as a rule changing degrees of node density along its area. Sensor systems are moreover vitality obliged since the person sensors, which the network is shaped with, are greatly energy-constrained as well. The communication gadgets on these sensors are little and have constrained control and range. Both the likely contrast of hub density among a few locales of the network and the vitality limitation of the sensor hubs cause hubs gradually pass on making the network less dense. Too it is very common to send WSNs in harsh environment, what makes numerous sensors inoperable or flawed. For that reason, these systems need to be fault-tolerant so that the requirement for maintenance is minimized. Typically the network topology is persistently and powerfully changing, and it is actually not a craved arrangement to recharge it by imbuing unused sensors instead the depleted ones. A genuine and suitable arrangement for this issue is to implement routing conventions that perform proficiently and utilizing the less sum of vitality as possible for the communication among nodes. Sensor devices in WSNs monitor the same occasion and report on them to the base station. In this manner, one great approach is to consider that sensors found in the same locale of the network will transmit comparative values of the qualities.

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the network less dense. Too it is very common to send WSNs in harsh environment, what makes numerous sensors inoperable or flawed. For that reason, these systems need to be fault-tolerant so that the require for upkeep is minimized. Typically the network topology is persistently and powerfully changing, and it is actually not a craved arrangement to recharge it by imbuing unused sensors instead the depleted ones. A genuine and suitable arrangement for this issue is to implement routing conventions that perform proficiently and utilizing the less sum of vitality as possible for the communication among nodes. Sensor devices in WSNs monitor the same occasion and report on them to the base station. In this manner, one great approach is to consider that sensors found in the same locale of the arrange will transmit comparative values of the qualities. Sensor networks require protocols, which are particular, information centric, capable of aggregating information and optimizing vitality utilization [1].

II. ROUTING

Routing is the way toward choosing best ways in a system. Before, the term directing was additionally used to mean sending system traffic among systems. Anyway this last capacity is vastly improved depicted as essentially sending. Directing is performed for some sorts of systems, including the phone organize (circuit exchanging), electronic information systems, (for example, the Web), and transportation systems. This article is concerned principally with steering in electronic information systems utilizing bundle exchanging innovation.

In packet switching systems, routing coordinates parcel sending (the travel of legitimately tended to organize bundles from their source toward their definitive goal) through middle hubs. Middle of the path hubs are regularly arrange equipment gadgets, for example, routers, bridges, gateways, firewalls, or switches. Universally useful PCs can likewise advance parcels and perform steering, however they are not specific equipment and may experience the ill effects of restricted execution. The steering procedure typically coordinates sending based on directing tables which keep up a record of the courses to different system goals. In this way, developing steering tables, which are held in the switch's memory, is essential for proficient directing. Most steering calculations utilize just a single system way at any given moment. Multipath directing procedures empower the utilization of numerous elective ways. In case of overlapping/equal routes, the following elements are considered in order to decide which routes get installed into the routing table (sorted by priority):

- Prefix-Length: where longer subnet masks are preferred (independent of whether it is within a routing protocol or over different routing protocol)
- Metric: where a lower metric/cost is preferred (only valid within one and the same routing protocol)
- Administrative distance: where a lower distance is preferred (only valid between different routing protocols)

The Routing Hierarchy has been show in the figure number 1.

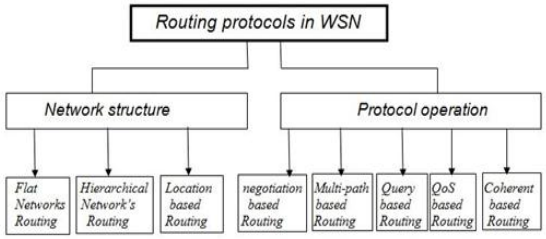


Fig 1: Taxonomy for WSN Routing Protocol

III. LITERATURE SURVEY

Burgos et al. [5] proposed LEACH which is versatile bunching convention for conveying the vitality load among the sensor hubs in the system. In [9] the author proposed another convention named M-LEACH which is a vitality efficient steering convention for portable remote sensor systems. This convention has a few highlights of LEACH, the area of bunch heads are picked to diminish the absolute power weakening. In this convention, amid the Setup stage, every hub sends data including areas, vitality level to the base station and amid the transmission stage, every hub sends information amid its assigned transmission time. In [10] Cluster-tree LEACH has been proposed which bolsters single or multi cluster systems. Each single group in multi-bunch organize goes about as a group head and these group heads are fixed in each bunch amid the lifetime of the system. This convention has expanded the lifetime of the

system by almost half of the first lifetime of the system. The author in [18] proposed PEGASIS, an insatiable chain convention which settle the information gathering issue of the remote sensor systems. The primary concern is for each hub to get from and transmit to close neighbors and alternate being the pioneer for transmission to the base station. This methodology will convey the vitality load equitably among the sensor hubs in the system. At first the hubs are set haphazardly in the field, and the sensor hubs are masterminded to frame a chain, which can either be cultivated by the sensor hubs themselves utilizing a voracious calculation beginning from some hub. Then again, the base station can figure this chain and communicate it to the various sensor hubs. For developing the chain, all hubs have worldwide information of the system and after that utilize the insatiable calculation. A circle will be built to guarantee that all hubs have close neighbors is troublesome as this issue is like the voyaging sales rep issue. The eager methodology to developing the chain is done before the first round of correspondence. It indicates better results when contrasted with LEACH by evacuating the overhead of dynamic bunch development, diminishing the quantity of transmissions, and utilizing just a single transmission to the base station per round and indicates better improvement if the system estimates increments. Manjeshwar and Agrawal in [7] proposed Youngster which is the first convention created for receptive systems. In this, at each group change time, the bunch head communicates to its individuals. In this manner, the hard limit attempts to lessen the quantity of transmissions by permitting the hubs to transmit just when the detected characteristic is in the scope of intrigue. The delicate limit further decreases the quantity of transmissions by wiping out every one of the transmissions which may have generally happened when there is almost no adjustment in the detected characteristic when the hard limit. The primary disadvantage of this conspire is if the edges are not accomplished, the hubs will never impart, the client will not get any information bundle from the system and won't come to think about the hubs on the off chance that they kick the bucket. Consequently, this plan isn't well appropriate for applications where the client needs to get information normally. Another issue is that a down to earth execution would need to guarantee that there impact free group. In [11] the author had proposed SOP convention which incorporates bunch design of Drain with multi-bounce directing to diminish transmission vitality. In numerous WSN multi-jump steering is received. This makes a hub that needs to transmit information to a goal hub and one or numerous middle hubs. The correspondence happens among every one of the hubs until the information bundles achieve the goal in. In short, the information bundles take a few jumps among the hubs in the system. The fundamental preferred standpoint of this methodology is that transmission vitality utilization is decreased. In [19] has proposed HEEP and improved system execution utilizing directing calculation furthermore, improves hand-off hub situation plot for remote sensors systems.

IV. ENGERY EFFICIENT PROTOCOL

A. LEACH

Heinzel man, et.al [6] presented a progressive routing calculation for sensor Systems, called Low Energy Adaptive Clustering Hierarchy (LEACH). LEACH organizes the hubs in the system into little bunches and picks one of them as the group head. Hub first faculties its objective and afterward sends the important data to its bunch head. LEACH operations can be divided into two phases:-

1. Setup phase
2. Steady phase

In the setup phase, the clusters are formed and a cluster-head (CH) is chosen for each cluster. While in the steady phase, data is sensed and sent to the central base station.

The steady phase is longer than the setup phase. This is done in order to minimize the overhead cost.

1. Setup phase: - Amid the setup stage, a foreordained portion of hubs, p, pick themselves as group heads. This is finished by a limit esteem, T(n). The limit esteem relies on the ideal rate to turn into a bunch head-p, the current round r, and the arrangement of hubs that have not turned into the group head in the last 1/p rounds, which is indicated by G. The formulae is as follows

$$T(n) = \frac{p}{1 - p \times (r \times mod \frac{1}{p}} \forall n \in G$$

B. TEEN

TEEN (Threshold sensitive Energy Efficient sensor Network protocol) is targeted at reactive networks and is the first protocol developed for reactive networks, to our knowledge [7].

Functioning

In this scheme, at every cluster change time, in addition to the attributes, the cluster-head broadcasts to its members,

Hard Threshold (HT): This is a threshold value for the sensed attribute. It is the absolute value of the attribute beyond which, the node sensing this value must switch on its transmitter and report to its cluster head.

Soft Threshold (ST): This is a small change in the estimation of the detected characteristic which triggers the hub to switch on its transmitter and transmit.

The hubs sense their condition constantly. The first run through a parameter from the characteristic set achieves its hard limit esteem, the hub switches on its transmitter and sends the detected information. The detected esteem is put away in an inner variable in the hub, called the detected esteem (SV). The hubs will next transmit information in the present bunch time frame, just when both the accompanying conditions are valid:

1. The present estimation of the detected quality is more noteworthy than the hard edge.
2. The present estimation of the detected quality varies from SV by a sum equivalent to or more prominent than the delicate limit. At whatever point a hub transmits information, SV is set equivalent to the present estimation of the detected quality.

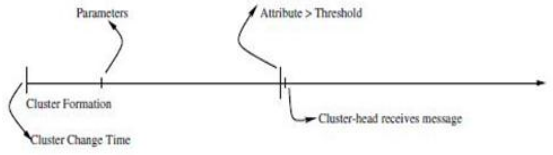


Fig 2: Time Line of TEEN

C. APTEEN

In APTEEN once the CHs are chosen, in each group period, the bunch head first communicates the accompanying parameters:

Attributes (A): This is a lot of physical parameters which the client is keen on getting information about.

Thresholds: This parameter comprises of a hard limit (HT) and a delicate edge (ST). HT is a specific estimation of a quality past which a hub can be activated to transmit information. ST is a little change in the estimation of a quality which can trigger a hub to transmit information once more.

Schedule: This is a TDMA plan like the one utilized in [8], doling out a space to every hub.

Count Time (TC): It is the most extreme timespan between two progressive reports sent by a hub. It tends to be a several of the TDMA plan length and it represents the proactive part.

In a sensor organize, near to hubs fall in a similar group, sense comparable information and endeavor to send their information all the while, causing conceivable crashes. We present a TDMA calendar with the end goal that every hub in the bunch is doled out a transmission opening, as appeared in Fig. 3. In the accompanying area, we allude to information esteems surpassing the edge esteem as basic information.

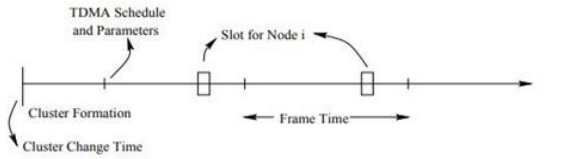


Fig 3: Timeline for APTEEN

D. MODTEEN

The main features of MOD TEEN are as follows:

- It is a reactive in nature.
- It is the optimized form of TEEN protocol
- Real time critical data is sent to the base station almost immediately after sensing abnormality. Thus, it is suitable for time critical applications.
- Since message transmission consumes large amount of energy, it is better than its proactive counterpart as data is sent only when the change is abnormal compared to the prescribed threshold value.

MODTEEN has been developed to overcome the short comes of TEEN protocol. In TEEN protocol if the attributes falls below the Threshold then the user may not get any kind of data at all which tends to timeslot waste. If all the nodes are included during the communication but due to the above said error the user is not getting any data then it just degrades the network performance. TEEN uses the threshold value in order to control its transmission operation. The cluster heads are chosen using LEACH's temporary

random formula which is mentioned in the following equation

$$Tn = p/(1 - p\left[r.mod\left(\frac{1}{p}\right)\right])$$

After the cluster arrangement, each cluster head broadcasts a TDMA plan for all hubs related with it. At first, the sensor hubs are actuated to sense information from their environment as it were when there's an abrupt alter within the detected information which either over the Difficult Edge esteem or underneath the Delicate Edge esteem. The cluster heads are chosen utilizing the over Filter equation where p is the likelihood of determination of CH. The MODTEEN uses the same formula for CH selection but after modifying it. The modified formula is given by the following equation,

$$Tn = \frac{p}{\left(1 - p\left[r.mod\left(\frac{1}{p}\right)\right]\right).\left(\frac{tempf}{tempi}\right)}$$

V. NETWORK MODEL

These tiny sensor nodes have restricted vitality and memory constraints, and directing conventions that could potentially reduce the directing intricacy are alluring. One method for achieving this is to utilize a topology not the same as a traditional flat topology and dole out the steering obligations to only a few nodes and pivot this periodically. In this segment, we give a brief prologue to the sensor organize demonstrate on which we have based our protocols. We accept that every one of the hubs in the system are homogeneous and start with a similar introductory vitality. The BS has sufficient capacity to transmit straightforwardly to the sensor nodes, providing an immediate way for the down-connect. None the less, the sensor hubs can't generally do this in view of their limited power supply, prompting an awry correspondence. This stringent vitality imperatives, makes hierarchical clustering to be the most reasonable model for Wireless Sensor networks [16,17,18]. The fundamental highlights of such a design are:

- Every one of the hubs need to transmit just to their quick bunch head, in this manner sparing vitality.
- Just the bunch head needs to play out extra calculations on the information, for example, conglomeration, and so forth. Along these lines, energy is moderated.
- The bunch individuals from a group are for the most part adjacent to one another and sense comparable information and are aggregated by the CH.
- CHs at expanding levels in the chain of command need to transmit information over generally bigger separations. To disperse this utilization uniformly, all hubs take turns becoming the CH.
- Since just the CHs need to realize how to course the information towards its larger amount CH or the BS, it decreases its steering intricacy.

VI. SIMULATION

For LEACH, TEEN, APTEEN, MODTEEN WSN routing protocol we have used Matlab Simulator A simulation environment having 50nodes,100nodes in 500 x 300 flat grid has been created with random position.

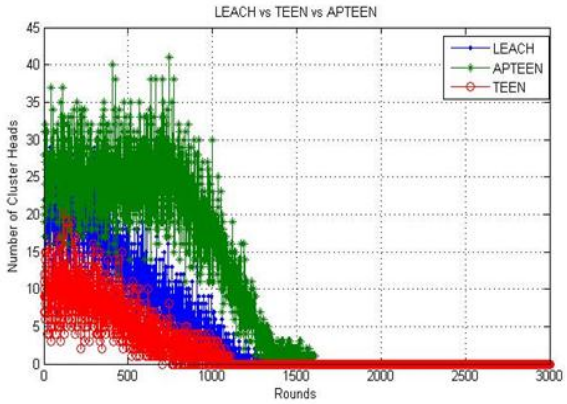


Fig 3: Number of CH of LEACH, TEEN, APTEEN

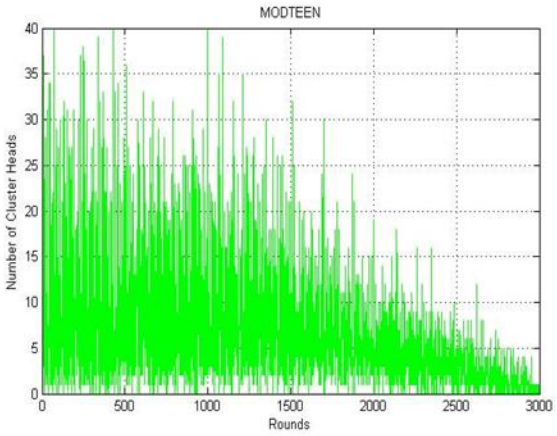


Fig 4: Number of CH of MODTEEN

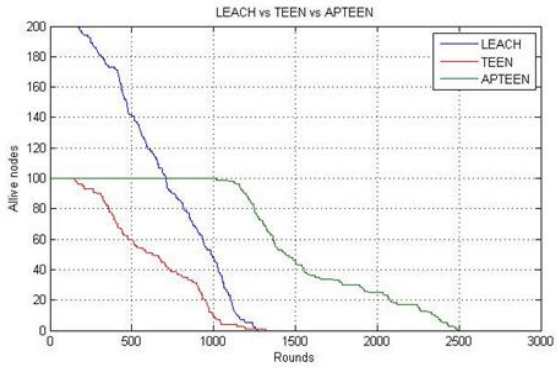


Fig 5: Number of Alive Nodes of LEACH vs TEEN vs APTEEN

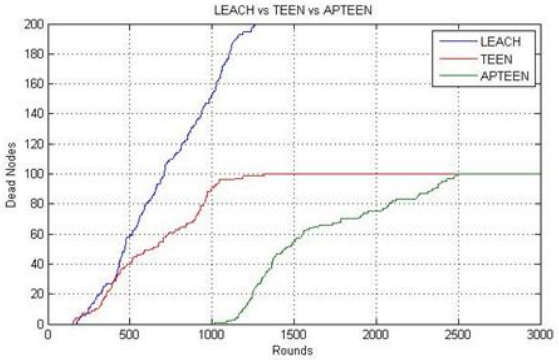


Fig 6: Number of Dead Nodes of LEACH vs TEEN vs APTEEN

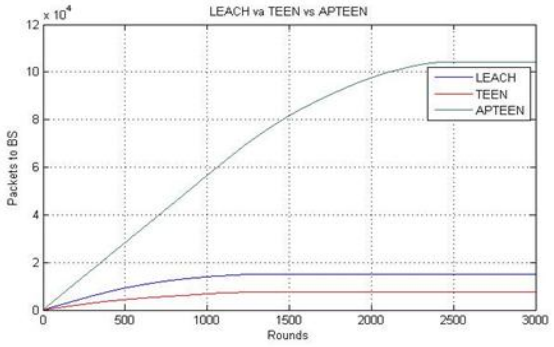


Fig 7: Number of Packets to BS of LEACH vs TEEN vs APTEEN

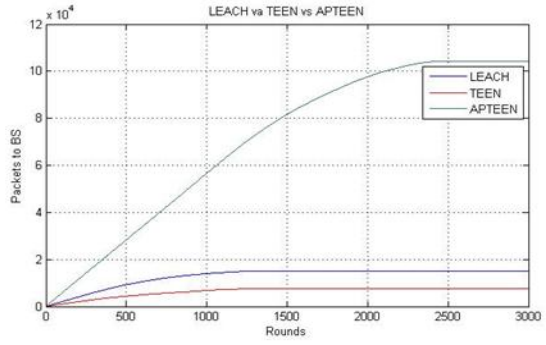


Fig 8: Number of Packets to CH of LEACH vs TEEN vs APTEEN

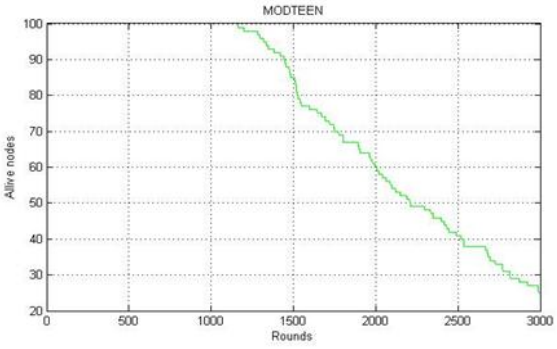


Fig 9: Number of Alive Nodes of MODTEEN

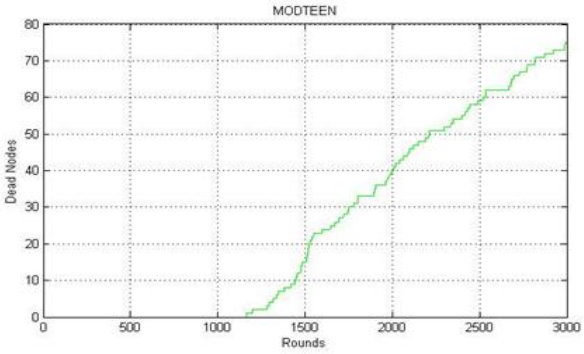
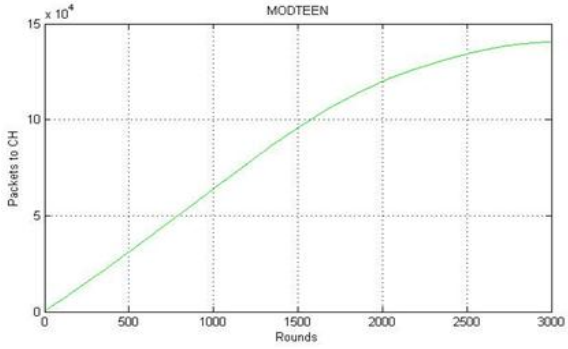


Fig 10: Number of Dead Nodes of MODTEEN

Fig 11: Number of Packets to BS of MODTEEN

Fig 12: Number of Packe



ts to CH of MODTEEN

VII. CONCLUSION

In this research work we have studied the LEACH, TEEN, APTEEN and MODTEEN protocol. Performance for all the protocols has been evaluated in MATLAB software. Few influencing parameter such as Cluster Head, Number of Dead Node and Number of Alive Nodes has been calculated for 3000 number of rounds execution. We have compared LEACH and TEEN algorithm. Among these two algorithm the TEEN performs better because LEACH is proactive network protocol whereas TEEN is reactive network protocol. In a proactive network larger number of nodes will be included during the communication as compared to the reactive network protocol. In case of all parameters the TEEN protocol performs better as compared to LEACH. Next we have compared three protocols such as TEEN, APTEEN and MODTEEN by using different parameter such as No of Dead Nodes, No of Alive Nodes, No of Packets to BS and No of Packets to CH. In case of first two parameters MODTEEN performs better and the number of nodes are included during the communication on demand basis. Among all algorithm the APTEEN executes in hybrid network but other two algorithms are based on reactive network. Due to the hybrid nature the no of nodes included in APTEEN is high as compared to other two but among TEEN and MODTEEN, MODTEEN performs good because less number of nodes are included during the communication. In TEEN and APTEEN initially the number of active nodes will be very high but in case of MODTEEN initially the number of active nodes remains low but gradually it increases as the number of rounds increase. As the number of round increases the data traffic goes to the peak position. In case of Number of packets to the BS and CH TEEN performs better because after some rounds of communication there will constant rate in delivering packets to BS and CH. By examining aver all parameters MODTEEN performs better as compared to TEEN, APTEEN and LEACH protocol.

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