Comparative Analysis on Cluster based Hierarchical Routing Protocols for Wireless Sensor Networks

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***Abstract*:- Wireless sensor networks (WSNs) are a collection of sensor nodes. The concept of Routing is used to routes the data packets from one place to another. WSNs have recently gained a lot of attention by scientific community. The most important key issue for research purpose in WSN is the Routing protocol. As indicated by organized network the routing protocols can be broadly described as flat and hierarchical routing protocol. The paper presents a few common progressive hierarchical routing protocols in detail and is investigated on their performance in network. Likewise, routing protocols share prominent role in terms of competence in WSN. Due to restrictions of resources in the sensors, it is difficult to plan an effective design of efficient routing protocol. The paper investigated Hierarchical based routing protocols the routing techniques.**

Keywords : Hierarchical Routing Protocols, LEACH, WSN, Clustering, Switching

INTRODUCTION

WSNs are most developing zones because of the progression of wireless advancements. Their applications incorporate monitoring, natural calamity management, maintenance and so on [1, 2] Routing is a fascinating research issue in WSN. But at the same time it is a mind boggling employment to build up a routing protocol which is effective due to its highly dynamic network. Because of power constraints in the wireless networks, various network protocols are required. These protocols incorporate controlling network and administration capacities, for example, data synchronization, placement of node and security issues. Due to this existing routing protocols can't be incorporated in the WSN.

Paper is isolated into Section II arrange configuration issues, area III presents distinctive directing strategies used in WSNs, segment IV displays the Hierarchical based steering and Section V Concludes the paper.

DESIGN ISSUES IN WSN

Energy consumption, transmission capacity, processing capabilities, data storage is some of restrictions in WSN. There are many design issues involved in a sensor network. They are listed below:

Restriction on Energy Limit: As the nodes are battery controlled, they have constrained limit of energy. Energy is a major issue for network engineers like in climate condition checking, it is difficult to get to the sensors and revive their batteries in natural calamities. Besides, when the energy of a sensor achieves a specific edge, it becomes defective and starts malfunctioning, which majorly affect the performance. Therefore, routing protocols implementation sensors ought to be as energy efficient as conceivable to enhance their lifetime and ensuring great performance.

Restriction on Hardware Resources: Besides constrained energy limit, sensor nodes have lack of processing capacity and hence can just perform few limited functionalities.

Restriction on Node Placement: In many applications, sensor nodes can be placed arbitrarily. In an event if the circulation of nodes is not uniform the ideal clustering plays an important to permit connection in sensor nodes and empower efficient network connectivity.

Unpredictable Environment: A sensor works in an ever changing and inconsistent condition. The topology continuously changes because of expansion or deletion of sensor nodes. Routing ways should consider change in topology as a result of limited vitality and sensor conveniences.

Data Aggregation: As nodes create repetitive information, same type of packets from different nodes can be collected so that the quantity of transmissions is decreased. Information collection is considered for vitality productivity and streamlined information move during the time spent directing. Different Protocols dependent on Location, Data-driven, Hierarchical, Mobility, Heterogeneity and QoS are there. We present a survey on various leveled convention in paper.

WSN ROUTING TECHNIQUES

Routing is utilized for finding and keeping up the energy effective paths for information to give energy efficient and genuine communication from source to goal [4]. Different routing strategies utilized in WSNs are presented in [5, 6, 7&8]. Processing the Route implies discovery of path from

source to Base Station.WSN classification of Routing Protocol on the basis of route processing is presented in Figure 1.

Routing Protocol is utilized to portray the major functionality of finding route to next hop and technique for data transfer, hierarchy and path formation. All the Routing methods are based on network operation are presented in Figure 1.

Network model plays an essential part in activity of WSNs. It is utilized to characterize two principle attributes of a system i.e. qualities of BS and attributes of SNs [3]. Classification of WSN routing protocol on the basis of Network design is shown in Figure2.

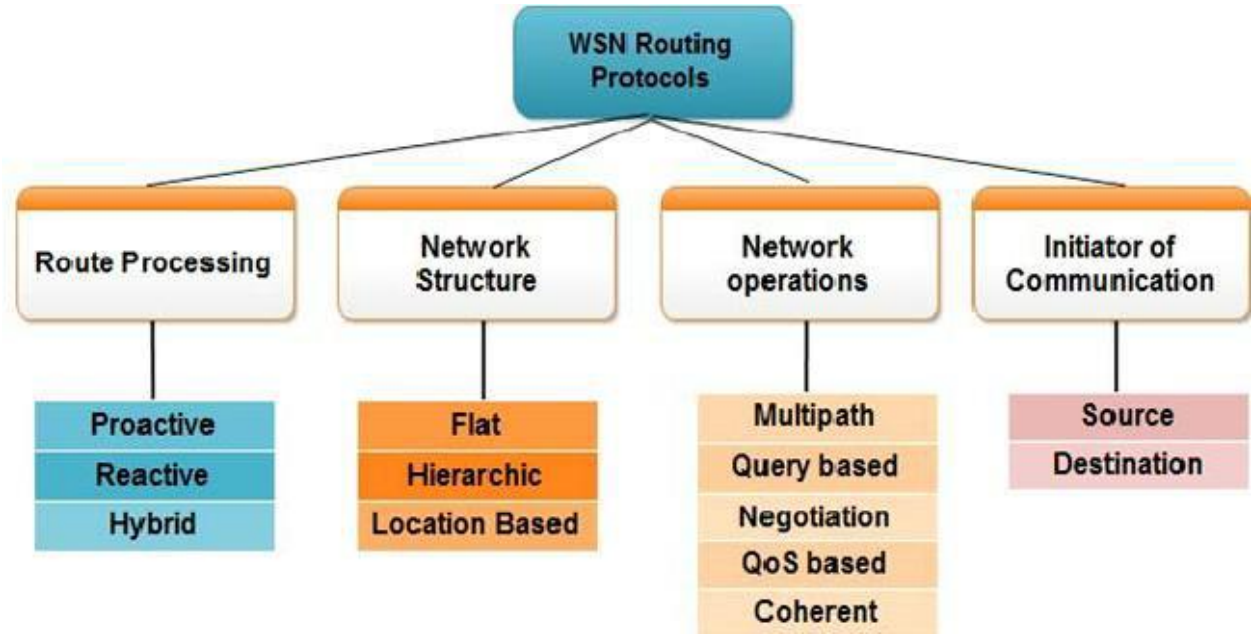

Figure 1: Classification.

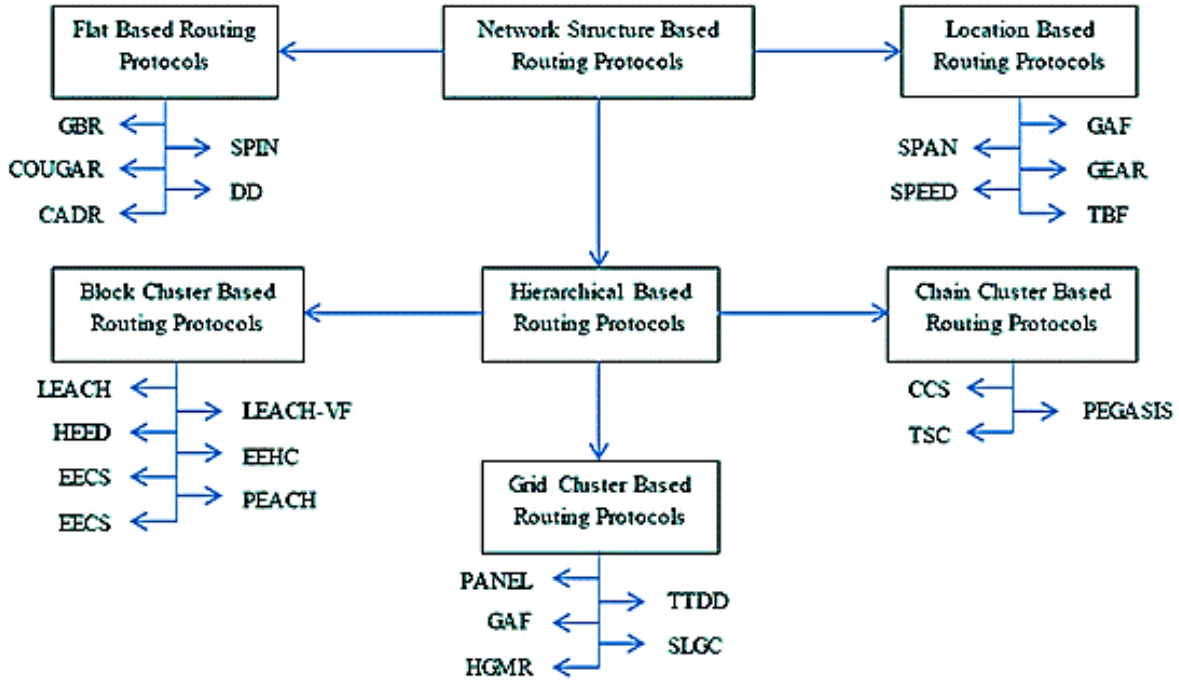

Figure 2: WSN Routing.

HIERARCHICAL ROUTING

Hierarchical routing [19] is considered as most known and recognized routing technique amongst all. In this strategy the topology breaks the entire system of sensors hubs into a couple of districts considered groups and each having a bunch head

displayed in Figure 3 [9]. The Cluster Head assumes the total data and sending the collected data and required information to the Base Station. A data exchange dependably happens from a lower clustered to the upper level.

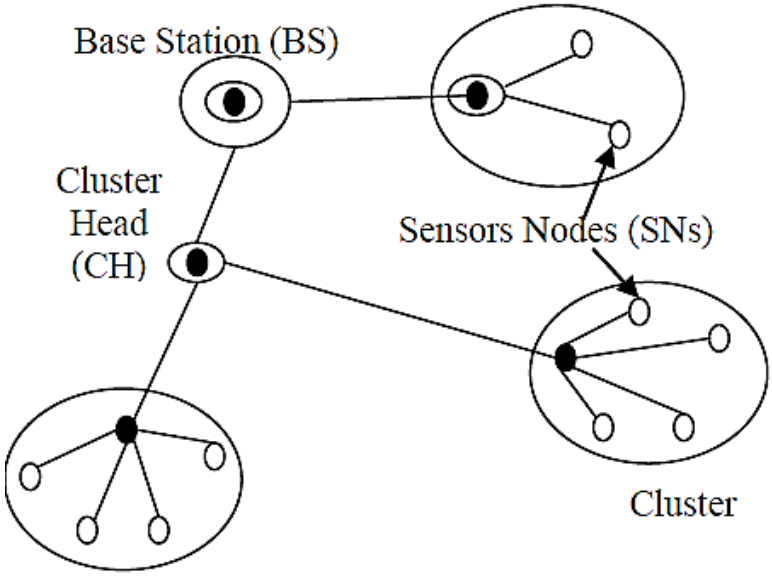

Figure 3: Hierarchical Cluster Model.

This type of routing is viably used to achieve energy efficient sensor networks [20].Clustering in sensor networks can be single- hop shown in Figure 4 and multi- hop in Figure 5. It utilizes layered approach of routing that states that one layer is for interchange the information amongst cluster head and the base station and second layer for data transfer amongst cluster heads and other nodes insame group. Sensors with highest energy is utilized as cluster head for data aggregation in every cluster where as other nodes are kept into rest mode when not in use for data transfer which have low energy level.

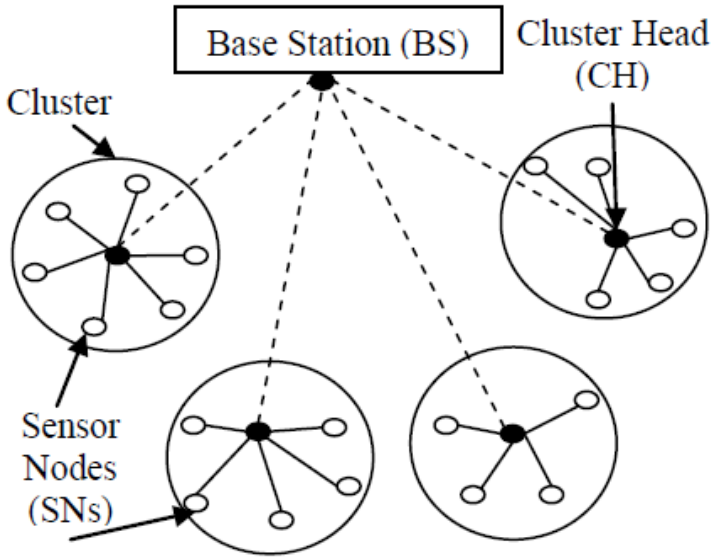

Figure 4: Single-hop Communication.

Both of these correspondences have their own particular positives and also negatives like single- hop correspondence experiences energy loss issue as with increase in distance while the multi- hop experiences the issue of energy hole.

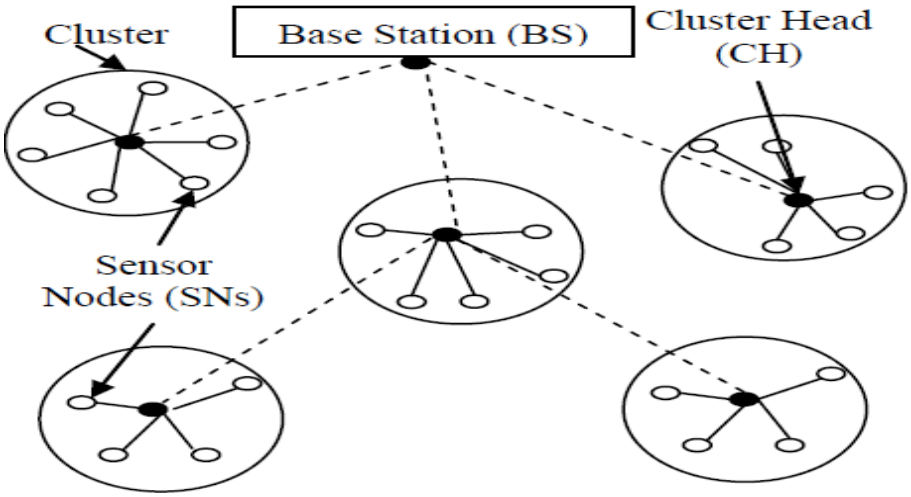

Figure 5:Multi-hop Communication.

The distinctive attribute of routing protocol of wireless sensor networks are listed below:

1. Energy usage of every node and its transmission cost is lessened. It is a critical objective of the plan of routing protocol to broaden the network [19].
2. Network scalability improved, dynamic system topology, simple to grow.
3. The routing table size should be decreased as to make routing mechanism straight forward and proficient.
4. Enough security should be incorporated with Routing protocol.
5. Bandwidth for Communication is monitored.
6. The interchange to CHs is less and accordingly reduces redundancy in exchanging data amongst the SNs.
7. Fault tolerance routing method should be implemented which makes it easily adjustable to the change in topology and hence cost decreased and efficiency enhanced.
8. The time of the network is improved by utilizing different strategies for boosting network.
9. The battery existence of node is improved by utilizing different network enhancement methods.

Different Kinds of Hierarchical-based Routing Protocols are

A. LEACH (Low Energy Adaptive Clustering Hierarchy Protocol)

It [5] is most famous clustering protocol for sensor systems which limits vitality dispersal of hubs. In this convention groups are made depending on the estimation of Strength of Received Signal of every hub and it uses bunch head as switches to the base station [10, 11].

This protocol utilizes irregular movement of the nodes for uniform sharing of energy resources which is needed for a node to be cluster head. The operational model represents, that on an average only 5% of the nodes will become as cluster head in a network. The sensor organize is parceled into gatherings and each group has a bunch head [12]. Another bunch head is sending all out information to the base station and it is transmitted utilizing Code Division Multiple Access configuration so as to avoid obstruction. These two segments used as impact shirking in each bunch and in gatherings.

The execution process of this protocol incorporates numerous phases and each phase has 2 stages. These are

- The first stage of set-up, clusters is framed and a head is chosen in a group.
- The second stage is steady information transmission stage; information is passed to the

Base station.

In Set-up stage, the cluster head depends on the condition of certain exceeded value. Every node creates an irregular value somewhere in the range of 0-1 and estimation of node is within that limit then it will end up being a cluster head for that phase.

$$T(n) = \begin{cases} \dfrac{P}{1 - P\left(r * mod\left(1/P\right)\right)} & if\ n \epsilon G \\ 0 & otherwise \end{cases}$$

P = chance of being cluster head,
r =reality round

G =nodes that are not cluster head in the current poch Where poch is defined as rounds after making it eligible again for becoming cluster head.

Becoming Cluster Head, it sends its status of being Cluster Head by utilizing CSMA MAC protocol. Every node picks their Cluster Head based on RSSI value of each Cluster Head. Nodes transmit messages to their Head utilizing CSMA MAC protocol. In steady state stage, node transmit data to separate head in its given time slot. After that each head consolidates and data and exchange it to BS.

B. PEGASIS (Power-Efficient Gathering in Sensor Information Systems)

PEGASIS [13] is a refined protocol over LEACH that is implemented to enhance life of sensor network. In PEGASIS, nodes are partitioned in whole network and each node is allowed to send its information just to its nearest adjoin node [14]. Node takes its separation to the adjoin node by means of signal strength in order to find the nearest node. Implementing Greedy Algorithm a chain is form from node to the base station. Then a node is chosen as pioneer to transmit the information from node to the base station. Hence Bandwidth utilization drops and then the overhead issue decreases from BS.

C. Hybrid Energy-Efficient Distributed protocol (HEED):

HEED expands the fundamental plan of LEACH by utilizing residual energy and node degree for cluster determination to accomplish power balancing. It operates on the concept of multi hop networks, utilizing a versatile data transfer capacity in the between cluster. Four essential objectives are:

a) Improving network lifetime by disseminating energy utilization,
b) Ending the grouping procedure inside a consistent number of cycles,
c) Limiting control overhead,
d) Delivering all around dispersed cluster head and small clusters.

It chooses cluster heads as per a mix of two grouping measurable factor. The essential measurable factor is their residual energy of every sensor node and the second is the intra- cluster cost of communication. The essential measurable factor is utilized to choose an underlying arrangement of cluster head in light of likelihood while the other is utilized for breaking ties. It enhances network lifetime over LEACH grouping since LEACH randomly chooses cluster head, which leads to demise of a few nodes. The last cluster head chosen are very much portioned in network and the correspondence cost is limited. These strategies are appropriate for increasing the network lifetime.

D. TEEN (Threshold Sensitive Energy Efficient Sensor Network) Convention

This protocol [5, 7] is intended to detect the characteristics that are utilized foretime critical accomplishment like discovery of any explosion and it works on data centric methods using hierarchical way. Its designing follows same functionality of LEACH protocol which depends on various hierarchical clustering methods. Cluster head does not transfer data to the Base Station, rather it sends from lower level of cluster head to upper level of cluster head in hierarchy.

E. APTEEN

This protocol is an enhanced version of TEEN to incorporate occasional time to time data collection and utilities based on time response. APTEEN is a hybrid type of routing protocol for clustering that activates the sensor to transmit their detected data from time to time basis that reacts to the change in condition. The data then detected is sent to their respective cluster heads. The design of APTEEN is similar to that of TEEN, implements the hierarchical clustering for enhancing the energy efficiency.

F. SEP (Stable Election Protocol) Stable Election Protocol [15] in sensor arranges exhibits the impact of vitality heterogeneity of hubs that depend on progressive bunch. Its key target is to enhance the constancy of time period and decrease the frailty time of Sensor Networks.

It also suggests that a cluster head is framed in every cluster based on energy level weighted election probabilities of every node. It likewise guarantees that the cluster head is chosen that rely on the; energy of each node and guaranteeing proper utilization of node energy.

This protocol is an upgraded version over LEACH, where the capacity of LEACH is to develop a design and structure which gives add on energy in a network. The main distinction is that in the SEP it comprises of two diverse energy level 1 and 2 levels of hierarchy's are taken. A presumption states node inside the structure is not mobile and are scattered uniformly in the detecting zone. In this protocol 2 kinds of nodes i.e., Advanced and Normal node is thought about [16]. Advance node is few times extra energy in comparison to Normal node. Likewise, this protocol is an enhancement of LEACH in regard of cluster arrangement by reducing the timing slot of Advance node cluster head epoch.

The detection of Normal node as cluster head is given by specified threshold value as below:

$$T(S_{nrm}) = \begin{cases} \dfrac{p_{nrm}}{1 - p_{nrm}\left(r * mod\left(1/p_{nrm}\right)\right)} & if\ S_{nrm} \epsilon G' \\ 0 & otherwise \end{cases}$$

Where G' represents group of Normal nodes being cluster headRsays reality round Pnrmshows the loadextentof normal nodesthat can be calculated as:

$$p_{nrm} = \frac{P_{opt}}{1 + \alpha . m}$$

For detection of Advance node as cluster head the threshold parameter value can be calculated as:

$$T(S_{adv}) = \begin{cases} \dfrac{p_{adv}}{1 - p_{adv}\left(r * mod\left(1/p_{adv}\right)\right)} & if\ S_{adv} \epsilon\ G'' \\ 0 & otherwise \end{cases}$$

Here G'' represents set of Advance nodesthatbecamecluster headRshows existing round Padv is calculation of the loadextentofadvanced nodesand can be calculated as:

$$p_{adv} = \frac{P_{opt}}{1 + \alpha . m}(1 + \alpha)$$

Here m isextent of nodes having few times energy compared to normal nodes.

G. DEEC protocol (Distributed Energy Efficient Clustering)

This protocol [9, 17] relies on clustering approach, in which the cluster heads are chosen on basis of extends of residual energy and avg energy of the sensors. The epoch for every node is diverse due to its different energy level of starting and residual energy. Here node taking more initial and residual energy have higher chances of being cluster heads as contrasted with the nodes having low energy. This concept is fundamentally similar to that of SEP, as the two plans adjust the epoch of every node to its energy. This enhances the network life. Moreover, DEEC can likewise be viewed as satisfactory for the staggered sensors in heterogeneous approach.

For each node Si to be a cluster head in every round there is calculation of probability threshold value as represented as:

$$T(Si) = \begin{cases} \dfrac{p_i}{1 - p_i[r\ mod\left(\frac{1}{p_i}\right)]} & if\ s_i\ \mathcal{E}\ G \\ 0 & otherwise \end{cases}$$

G represents the group of SNs eligible for becoming CH at round r. Weighted election probabilities for Normal sensor node and for advanced sensor node in 2-level heterogeneous sensor networks [18] call are formulated as:

$$p_{adv} = \frac{P_{opt}}{1 + \alpha . m}$$

$$p_{nrm} = \frac{P_{opt}(1 + \alpha)}{1 + \alpha . m}$$

Therefore p_i is changed into

$$p_i = \begin{cases} \dfrac{p_{opt}\ E_i(r)}{(1 + \alpha m)\bar{E}(r)}, & if\ S_i\ is\ the\ nomal\ node \\ \dfrac{p_{opt}(1 + \alpha)E_i(r)}{(1 + \alpha m)\bar{E}(r)}, & if\ S_i is\ the\ advanced\ node \end{cases}$$

By putting the value of pi in T (Si) it calculates the probability threshold which is used to find cluster head. Here $\bar{E}(r)$ shows the average energy at round r, can be calculated as:

$$\bar{E}(r) = \frac{1}{N}\sum_{i=1}^{N} E_i(r)$$

CONCLUSION

The principle goal of the all the routing protocols is to make the node functional as far as feasible. Energy utilization directly proportional to routing method utilized. As far as increasing the network lifetime these protocols are energy efficient. In this research paper, we over viewed hierarchical routing. We have examined on how different types of hierarchical protocol work and identify their contrast parameters. Further many optimization techniques like swarm optimization, ant colony optimization and so on can be merged with these protocols for making the protocol more energy efficient and hence can further enhance the network performance.

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