A comparative study of Wireless Sensor Network cluster head selection algorithms

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Abstract : *. Wireless Sensor Networks (WSN) includes numerous sensor nodes that are connected to each other through the use of Wireless short distance links. The transfer of data between the individual nodes is found to be energy constrained and the energy-efficient protocol in WSNs is a huge requirement. In addition, the deployment of large numbers of sensor nodes increases the size of the network, which in turn increases the energy consumption rate. An efficient protocol is developed in this research that includes grid-based mobile communication network formation, efficient path selection through cluster head selection and data communication. In addition, multi-stage authentication is implemented to provide security from source node to destination node for the transfer of data. Sensor nodes life time is the most critical parameter. Many researches on this lifetime extension are motivated by LEACH scheme, which by allowing rotation of cluster head role among the sensor nodes tries to distribute the energy consumption over all nodes in the network. Selection of cluster head for such rotation greatly affects the energy efficiency of the network. Different communication protocols and algorithms are investigated to find ways to reduce power consumption. In this paper brief survey is taken from many proposals, which suggests different cluster head selection strategies and a global view is presented. Comparison of their costs of cluster head selection in different rounds, transmission method and other effects like cluster formation, distribution of cluster heads and creation of clusters shows a need of a combined strategy for better results.*

***Key words* – Wireless Sensor Network (WSN), Sensor nodes, Protocol, CH-Cluster Head, BS-Base Station**

I. Introduction

Wireless Sensor Networks (WSN) [1] consists of numerous autonomous sensor devices that are capable of communicating with each other. These sensor devices are deployed in real-world applications to sense information about the environment. The energy of these sensor nodes is limited, so the data collected from the environment is directly sent to the Base Station (BS). Smart sensor nodes composed of low power devices equipped with one or more sensors, a processor, a power supply, a memory, a radio, and an actuator. The sensors communicate over a short distance through a common medium to accomplish a common task. Wireless Sensor Network (WSN) comprises of small nodes that have certain components as in Fig(1) 1) Power source 2) Sensers 3) Micro Controller 4) Radio Tran-Receiver. WSNs have two broad categorical applications i.e., monitoring and tracking. In the current scenario, these WSNs operate on power sources like battery and hence organized energy consumption is highly required. These networks are highly reliable and are advantageous over conventional sensing devices. Also, they offer a very low-cost network deployment solution.

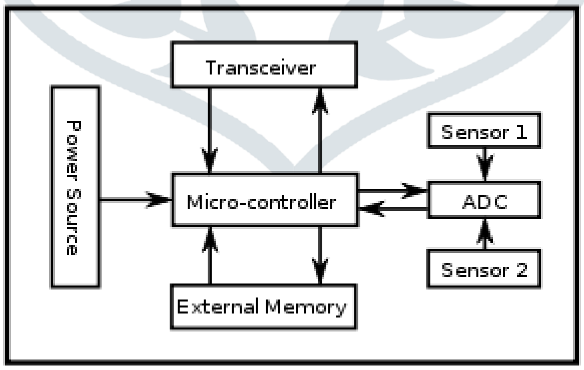

Fig. (1). The architecture of Wireless Sensor Node

II. Clustering

WSN protocols need to conserve energy as the main objective of maximizing the network lifetime. An energy-efficient communication protocol LEACH, has been introduced [1] Sensor nodes typically use irreplaceable power with the limited capacity, the node's capacity of computing, communicating, and storage is very limited, which employs a hierarchical clustering done based on information received by the Base station (BS). The BS periodically changes both the cluster membership and the cluster-head (CH) to conserve energy. The CH collects and aggregates information from sensors in its own cluster and passes on information to the BS. By rotating the cluster-head randomly, energy consumption is expected to be uniformly distributed. However, LEACH possibly chooses too many cluster heads at a time or randomly selects the cluster heads far away from the BS without considering nodes' residual energy. As a result, some cluster heads drain their energy early thus reducing the lifespan of WSN. In each round of the cluster formation, network needs to follow the two steps to select cluster head and transfer the aggregated data.

(i) Set-Up Phase, which is again subdivided in to Advertisement, Cluster Set-Up & Schedule Creation phases.
(ii) Steady-State Phase, which provides data transmission using Time Division Multiple Access (TDMA).

The election of cluster head node in LEACH [1] has some deficiencies such as, some very big clusters and very small clusters may exist in the network at the same time. Unreasonable cluster head selection while the nodes have different energy. Cluster member nodes deplete energy after cluster head was dead. The algorithm does not take into account the location of nodes. Ignores residual energy, geographic location and other information, which may easily lead to cluster head node will rapidly fail. Motivated from this, so many clustering proposals are reported in the literature, suggesting different strategies of cluster head selection and its role rotation.

III. Routing approaches in WSN

A number of routing approaches have been developed for the WSN till today. Due to its limitation in processing power and limited battery power, the routing protocols for the wired networks cannot be used in WSN. Different routing approaches can be adopted for the different domains based on their requirements. Domains can be time critical or requiring periodic updates, they may require accurate data or long lasting, less precise network, they may continuous flow of data.

Routing methods can even be enhanced and adapted for specific application. Basically, the routing protocol in WSNs can be classified into data-centric, hierarchical, location-based routing depending on the network structure as shown in figure 1. In data-centric, the sensor network takes the decision based on the data hold by the nodes in the network rather than

its destination addresses or geographical location. In hierarchical approach, some nodes in the network have added a load to reduce the load on the other nodes. In location based, the routing of the data is done by the geographical locations of the nodes it means that nodes are identified by its location only.

Data Centric Routing Techniques

A large number of the sensor's nodes are deployed over a region making it in comprehensible to assign a global identifier for each node. The sensors nodes in the region aggregate their sensed data and route back to the base station along the reverse path discovered in the previous step. Some of the protocols which follow the data-centric routing are.

- Directed diffusion
- SPIN
- Rumor routing

Directed diffusion: The data generated in the nodes is identified by its attribute-value pair. Here the base station passes its interest all through the network. The issued user interest would be traveling all through the sensor networks and compared with the event record in the concerned node. If the event record matches with the interest the event record is sent to the base station otherwise the interest is passed to the neighboring nodes. Here the use of gradients is an important factor in the direct diffusion technique. When the source node is responding to the base station, it will be receiving the data from multiple routes and again the base station has to select the gradient which is having minimum delay time than others. All sensor nodes in a directed-diffusion based network are application-aware, which enables diffusion to achieve energy savings by selecting better paths and by caching and processing data in the network. Caching can increase the efficiency, robustness, and scalability of coordination between sensor nodes, which is the essence of the data diffusion network.

SPIN: Sensor Protocols for Information Negotiation is the family of protocols based on data centric approach. It is also called as the 3-stage protocol since 3 subsequent steps are involved in data transformation between the nodes. When the node generates information, it is intimated to its 1-hop neighbors using ADV (advertisement) packet and if the neighbor node is in need of the information, it will request the data through REQ (request) packet. Finally, the original DATA packet will be sent to the neighbor node. Using this protocol redundancy in information is avoided in the sensor networks. The SPIN node will only take the data from its 1-hop neighbor nodes and only forward the best available data to the base station. The main drawback in this method is if a node which is in need of the data can't receive the data when it is not the 1-hop neighbor node to the source node which generates the required data. In SPIN, nodes poll their resources before data transmission. Each sensor node has own resource manager that keep track of resource consumption. This allows sensor to cut back energy consumption and bandwidth usage, by being more sagacious in forwarding third party data. SPIN provide high performance at low cost in terms of complexity, energy, computation and communication.

Rumor Routing: In this routing protocol the data collected by the sensor nodes will be sent to its neighboring nodes and it goes on till reaches the interested region or the end node of the network. At the same time the user interest is also sent through the network. When the two regions meet, each other required data are gathered and given to the base station. Rumor routing routes the queries to the events in the network and it offers tradeoff between setup overhead and delivery reliability. An event is an abstraction obtained from a set of sensor readings that is assumed to be a localized phenomenon occurring in a fixed region in the network. A query is a request for information, sent by the base station to collect data, and once the query arrives at its destination the data can begin to flow back to the queries originator. If there is significant amount of data to be sent, it is advisable to invest in discovering the shortest path from source to sink. There are various methods such as directed diffusion, which are energy inefficient as they rely only on query flooding until they reach the event location. But method such as rumor routing uses enhanced flooding approach which makes then more energy efficient. Rumor routing is a logical compromise between flooding queries and flooding event notifications. The goal is to create paths leading to each event; while event flooding creates a network wide gradient field.

Hierarchical Routing Techniques

Hierarchical routing is the procedure of arranging routers in a hierarchical manner. A hierarchical protocol allows an administrator to make best use of his fast-powerful routers as backbone routers, and the slower, lower powered routers may be used for access purposes. In this way, the access routers form the first tier of the hierarchy, and the backbone routers form the second tier. Hierarchical protocols make an effort to keep local traffic local, that is, they will not forward traffic to the backbone if it is not necessary to reach a destination. The cluster head (CH) aggregates the sensed data from all

transmits it to the BS as shown in figure 2. Some of the protocols which follow the hierarchical routing are,

- LEACH
- PEGASIS
- TEEN & APTEEN

. LEACH Protocols

Heinzelmon introduced a hierarchical clustering algorithm for sensor networks. LEACH is a self-arranging, clustering convention and based on round-based technique. LEACH expect that the BS is settled and arranged far from the sensors, all sensors are homogenous and have confined energy source, sensors can sense the earth at a changed rate and can grant among each other, and sensors can particularly compare with BS. The considered LEACH is to deal with the nodes and divides them into groups to distribute the energy among the sensor nodes in the network, and in each group, there is a control node called a CH as shown in Figure 1. In Wu and Wang [2] and Fu et al,[3] LEACH procedure is indicated. Each round in LEACH involves 2 phases. The process of cluster set-up, advertisement, and schedule creation phase forms setup phase. [2] At the beginning of the setup phase, every node picks a random number some place around 0 and 1, and after that figures an edge condition.[4] If the picked subjective number is less than the threshold numberT(n), the node becomes a fortunate CH for such round. Threshold number T(n) is shown in Equation 1.

$$T(n) = \begin{cases} \dfrac{P}{1-P\times\left(r \bmod \dfrac{1}{P}\right)} \; if\ n \in G \\ 0 \; otherwise \end{cases}, \qquad (1)$$

where P is the CHs desired percentage, r is the current round, and G is the competing nodes that was not chosen as CHS in the last 1/P rounds. Node gets to be CH for the current round if the number is not as much as limit T(n). When node is chosen as a CH, then it cannot get to be CH again until every one of the nodes of the group has gotten to be CH once. This is valuable for adjusting the energy utilization. Steady state is the second phase; non-CHs get the CH requests and after that send join demand to the CH advising that they are individuals from the group under that CH.7 During the steady-state phase, each sensor node aggregates and transmits data to its CH in perspective of the TDMA schedule. TDMA/CDMA MAC is used in LEACH protocol to resist intercluster and intracluster collision.[5] The CHS get each one of the data and aggregate it before being sent to the BS. After a time, which is determined from the before, the frame- work starts another round by withdrawing to the setup and persisting state arranges yet again. Sensors measure real-world conditions, such as heat or light, and then convert this condition into an analogue or digital representation. To select a cluster head following steps are followed as in Fig (2)

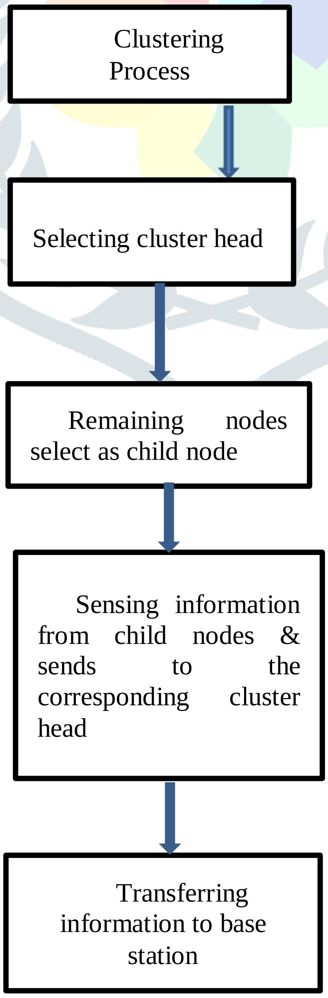

Fig. (2) Selection process of cluster head

PEGASIS: is a near optimal chain-based protocol. The basic idea is for the nodes to communicate their sensed data to their neighbors and the randomly chosen nodes will take turns in communicating to the BS. It assumes that the BS is fixed at a far distance from the sensor nodes. The sensor nodes are homogeneous and energy constraint with uniform energy. The energy cost for transmitting a packet depends on the distance of transmission. All the nodes maintain a complete database about the location of all other nodes. This method had been named as Power Efficient Gathering in Sensor Information System [8]. Instead of forwarding the packets from many cluster heads as like in LEACH protocol here in PEGASIS each node will form a chain structure to the base station through which the data would be forwarded to the BS node. Here in PEGASIS energy efficient is achieved by transmitting the data to only one of its neighbor nodes. There the collected data is fused and the fused data will be forwarded to its immediate one hop neighbor. Since all the nodes are doing the data fusion at its place there is no rapid depletion of power for the nodes present near the Base station. Also in this method, each node will be getting the chance to forward the gathered data to the base station. The improvement of PEGASIS, Hierarchical PEGASIS, was introduced with the objective of decreasing the delay incurred for packets during transmission to the BS. Energy balancing PEGASIS is the energy efficient chaining algorithm in which a node will consider average distance of formed chain. PEDAP, Power Efficient Data Aggregating Protocol uses spanning tree approach instead of Greedy approach to form the chain resulting in considerable savings energy.

TEEN: Threshold sensitive energy efficient protocol (TEEN) and Adaptive threshold sensitive energy efficient protocol (APTEEN) are the two-threshold sensitive hierarchical routing protocols based on the clustering approach used in LEACH. LEACH is targeted at proactive network applications where as TEEN and APTEEN are targeted at the reactive network applications. In proactive network, the sensed data is sent periodically to the sink which provides the snap shot of relevant parameters at regular intervals. In reactive networks the nodes react immediately to the sudden change in the sensed data and transmit it to the sink. Since they remain in the sleep mode most of the time, the number of transmissions is reduced, thus reducing the energy consumed. TEEN mainly focuses on time critical sensing applications. The soft threshold can be varied depending on the criticality of the sensed attribute and the target application. The user can change the threshold values at every cluster change time by broadcasting the new attributes. The message transmission consumes more energy than data sensing. So, even though the node senses continuously, the energy consumption in this scheme can be potentially much less than in the proactive network, cause data transmission is done less frequently. A smaller value of the soft threshold gives a more accurate picture of the network, at the expense of increased energy consumption. One user can control the trade-off between energy efficiency and accuracy.

APTEEN: APTEEN is an improvement over TEEN which can transmit data based on the thresholds and also periodically. It is applicable in both proactive and reactive networks and it can adapt itself to the application requirements. Once the CH are decided in each cluster period, the CH first broadcasts a set of parameters, attributes (the set of physical parameters of the environment in which the user is interested), thresholds (this parameter consists of the hard and soft thresholds), schedule (this is a TDMA schedule for assigning a slot to each node), (Tc) Count Time (it is the maximum time period between two successive reports sent by a node. It can be a multiple of the TDMA schedule length and it accounts for the proactive component).

Location Based Routing Techniques

Routing algorithms which are using geographical location is an important research subject in wireless sensor network. The routing of data to the nodes are identified by its location of the nodes. They use location information to guide routing discovery and maintenance as well as packet forwarding, thus enabling the best routing to be selected, reducing energy consumption and optimizing the whole network. The location information of the nodes is obtained by the low power GPS receivers embedded in the nodes. Some of the most important protocols coming under the Location Based Routing strategy are,

- GAF
- GPSR
- GEAR

Geographic Adaptive Fidelity (GAF): is a location-based routing protocol for WSN. It is also an energy aware routing protocol. GAF works in such a way that, it turns off unnecessary nodes in the network without affecting the level of routing fidelity, this conserves energy. A virtual grid for the area that is to be covered is formed. The cost of packet routing is considered equivalent for nodes associated with the same point on the virtual grid. Such equivalence is exploited in keeping some nodes located in a particular grid area in sleeping state in order to save energy. By doing this the network lifetime is increased as the number of nodes increases.

Greedy Perimeter Stateless Routing (GPSR): The modified version of greedy-face-greedy algorithm is the Greedy perimeter stateless routing . Here the combination of greedy and perimeter approach is taken. Initially the data is forwarded by using greedy approach and if the packet gets stuck at any point, perimeter approach comes to rescue of the situation. But this perimeter approach is followed till a node closer to the destination was found than the node at which the packet got stuck. It ensures the guaranteed delivery of packets to the destination.

Geographic And Energy Aware Routing (GEAR): Geographic and Energy Aware Routing algorithm or simply known as GEAR is a location-based routing protocol for WSN. GEAR is an energy efficient protocol which uses the energy aware neighbour selection to route a packet towards a particular geographical region and then use either the recursive geographic forwarding or restricted flooding algorithms to disseminate the packet inside the destination region. GEAR shows considerably longer network lifetime than most non-energy aware geographic routing algorithms especially for non-uniform traffic distribution when compared to uniform traffic distribution. This protocol is used by considering the least cost path to route the packets to the destination node which is identified by its location information.

Comparison of Routing Protocols: In this paper, I compare the following routing protocols according to their design characteristics. Table 1 represents Classification and Comparison of routing protocols in WSNs.

Routing Protocols	Classification	Power Usage	Data Aggregation	Scalability
Directed Diffusion	Flat/ Data-centric/ Dst-initiated	Limited	Yes	Limited
SPIN	Flat/ Src-initiated/ Data-centric	Limited	Yes	Limited
Rumor Routing	Flat	Low	Yes	Good
LEACH	Hierarchical/ Dst-initiated/ Node-centric	High	Yes	Good
PEGASIS	Hierarchical	Max	No	Good
TEEN & APTEEN	Hierarchical	High	Yes	Good
GAF	Hierarchical/ Location	Limited	No	Good
GPSR	Location	Limited	No	Good
GEAR	Location	Limited	No	Limited

Table(1) Comparison of Routing Protocols

IV. Performance Metrics of Cluster-Based WSN

In this section, a set of performance metrics are enumerated which can be used to categorize and differentiate cluster-based WSN algorithms. One of the benefits of clustering is to make network scalable in situation when sensor nodes' number is huge. Nevertheless, there are downsides of using a cluster-based network, such as higher cost overhead during network construction as compared to flat sensor network. Cost of clustering is an important parameter to authenticate the effectiveness of the scheme. Moreover, it also refers to the improvement of network structure in terms of network scalability. Cost of the clustering schemes in this paper is evaluated qualitatively and quantitatively. The effectiveness of each algorithm as well as their shortcomings are determined. In this part, various performance metrics of cluster-based WSNs are discussed. Based on these parameters, the cost of clustering is evaluated more efficiently. Fig (3) describes various performance metrics of cluster-based WSN and each performance metric is discussed afterwards.

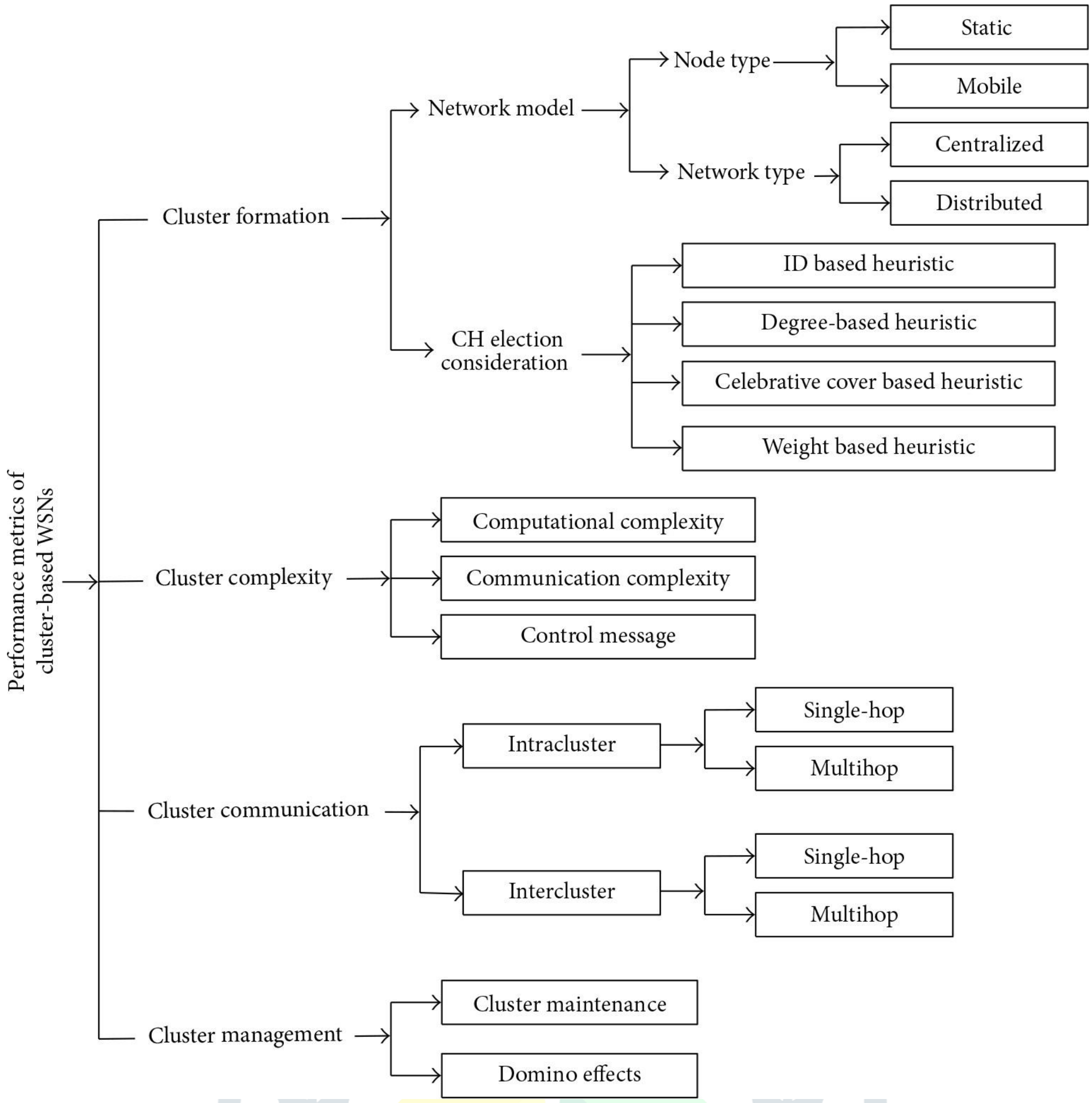

Fig (3) Performance Classification of Cluster based WSN

Cluster Formation. Cluster formation is the setup phase of building cluster-based architecture from flat sensor network. Cluster formation is divided into two categories, namely, network model and cluster-head election.

Network Model. Network model represents the characteristics of a network. Two basic components of network model are described below.

Node Type. A node can be of two types, either mobile node or stationary node. In the former way, CHs, MNs, or GWs or all three can be mobile. Therefore, mobile node (CH or MN) changes its position dynamically in terms of other nodes. A challenging problem in such scenario is to retain cluster for long time and to overcome problems associated with packet loss. On the other hand, in stationary nodes, CHs, MNs, and GWs are the static nodes that do not change their positions in terms of other nodes [20].

Network Type. In WSN, cluster formation is either distributed or centralized. In centralized technique, a base station or CH needs universal information about the sensor network. In the distributed technique, a node becomes either CH or member node without the entire network information.

Cluster-Head Election. CH election can be of different types: ID-based heuristic [6], degree-based heuristic [7], coverage based heuristic [8], and greater weight based heuristic. In ID-based heuristic, node ID is taken into consideration for CH election, like a smallest ID node becomes CH. In degree-based heuristic, quantity of neighbors is considered for CH election, while collaborative cover based heuristic considers average hop distance between two communicating nodes. It is indicated in [9] that the degree-based heuristic is better than ID-based heuristic in recognizing smaller size CDSs. However, collaborative cover heuristic [8] is better than degree-based heuristic in recognizing smaller size CDSs. Moreover, in weight-based clustering, various parameters are considered to elect CH, such as remaining energy, communication cost, and distance. In weight-based criterion, a node is elected as a CH based on energy cost.

Cluster Complexity. Cluster complexity defines the transmission complexity of the network. There are two types of cluster complexity, namely, computational complexity and communication complexity.

Computational Round/Time Complexity. Computational round specifies the total number of rounds in which cluster formation is accomplished. Computational round is a significant metric in cluster formation for static and mobile sensor network. It indicates an unbound time complexity in mobile sensor nodes. Hence, the more round results more data communication which decreases the efficiency of clustering algorithms [10].

Communication Complexity/Message Complexity. Message complexity is categorized into three types that are data aggregation, broadcasting, and multicasting. Converge-casting is an example of data aggregation that is performed at CH level and initiated from bottom to top manner towards the base station (BS). In broadcasting, messages are disseminated from top (base station) and go down in the entire network [12], while in multicasting, messages are disseminated from one node to set of nodes. Moreover, communication complexity is also dependent on the number of edges.

Control Message. During network formation and maintenance, nodes exchange control information, which is unlike data message. Control message is directly proportional to energy depletion of a node. Moreover, the control information results in more energy depletion and vice versa. All the studied algorithms in this paper are evaluated via three scales: low, medium, and high [12, 13].

Cluster Communication. Cluster communication is a data sending mechanism from MNs to CH and from CH to base station. There are two types of data communication mechanism and those are intracluster and intercluster.

Intracluster Communication. In cluster-based WSN, intracluster communication is diversified into two approaches, such as single-hop intracluster communication manner and multiple-hop intracluster communication manner. In the case of single-hop intracluster, all MNs in the cluster send data to the corresponding CH straightly, while in multihop intracluster data moves through intermediate MNs in order to convey the message to the corresponding CH. Single-hop intracluster performs efficiently comparatively multihop intracluster communication in terms of energy conservation [14, 15].

Intercluster Communication. In cluster-based WSN, intercluster communication is also diversified into two classes which are single-hop intercluster communication manner and multiple-hop intercluster communication manner. In the case of intercluster single-hop, all CHs communicate with the BS directly. In contrast, data is relayed through intermediate nodes towards base station in intercluster multiple-hop. To increase scalability of sensor network, multihop intercluster communication performs efficiently as compared to single-hop intercluster routing [16].

Cluster Management. Cluster management deals with the topological manipulation in the cluster-based WSN. It is categorized into two types: cluster maintenance and domino effects.

Cluster Maintenance. Cluster-based network formation deals with the clusters formation, where cluster maintenance handles the topological changes when clusters are formed. Cluster topology manipulates new neighboring node discovery or the existing node leaving the cluster-based network. Thus, cluster maintenance deals with updating the cluster structure according to the change network topology. If clustering scheme is not scalable enough to facilitate cluster maintenance, then it results in domino effects. Thus, the whole network needs to be rebuilt from scratch [17, 18].

Domino Effects. There are some situations where cluster-based network is rebuilt from scratch due to damage or movement of sensor node. Such situation occurs when cluster has no maintenance mechanism. In other words, domino effect results in re-clustering the entire network when the existing nodes want to leave or new nodes want to join the network while maintenance mechanism is absent in the network [19].

V. Survey on different Wireless Sensor Network Routing protocols

I-LEACH Protocol: This protocol is a self-healing and adaptive clustering technique that is designed for a heterogeneous environment. In this protocol, a special type of high energy node called a normal node/cluster head/gateway is used to take the responsibility of CH and perform all the CH's function.

IB-LEACH Protocol: An extension of LEACH named IB-LEACH was proposed. Unlike LEACH, the IB-LEACH adopts three rounds for the transmission process. The rounds are set-up phase, pre-steady and steady phase. The additional pre-steady phase calculates the workload of one frame and chooses such CM who can work as CH.

ECLCM Protocol: According to this protocol each SN of WSN with a prior-probability function as criteria to be a CH. The theme of ECLCM is to reduce energy consumption in the multi-hop communication process. The initial assignment of CH probability enables each SN to advertise its eligibility for CH to the neighbour SN. In a particular time, span, each SN receives many advertises regarding CH but, the one with less hop-count with BS is elected as CH.

ECBDA Protocol: This creators proposed a proficient information collection algorithm to improve the soundness and lifetime of WSN. The centre methodology of ECBDA is to partition the entire sensor arrange into a limited number of bunches. At that point, from each bunch, the SN with the most elevated leftover vitality has been chosen as CH. Further, for information transmission, it utilizes Time-division different access (TDMA) time planning for every SN to send their gathered information to CHS. CH total that information by evacuating repetitive data and sent to the BS.

DCEBC Protocol: This CH election process primarily focuses on enhancing the life span of heterogeneous WSN. Here, the CH election based on two factors such as; probability threshold and current residual energy. This protocol aims to enhance the network lifetime by reducing energy consumption.

FEED Protocol: It proposes an imperativeness beneficial clustering system, which picks reasonable CHs by contemplating extra essentialness, density, arranging, and the partition between canter points. The makers have sent an administrator center for each CH which goes about as a substitute center if there ought to be an event of CH falls dead. This property causes an augmentation in structure lifetime what's more desires the system to be inadequacy indulgent. It requires the general circumstance of sensor centers and message correspondence for CH affirmation, which is an expensive and imperativeness consumable strategy.

LBC Protocol: This protocol have been proposed as a calculation to improve the lifetime of the sensor arrange. The clusters are encircled only once during the lifetime of the sensor arrange. CHS going to depend upon the rest of the vitality of CHs. The turn repeat timing of CH relies upon the vitality utilization of SNs for various assignments performed by the CH in the lifetime of the sensor arrange. This guarantees that balanced vitality usage by all SNs present in a bunch brings a deferred framework lifetime. The proposed show is static; the CH decision strategy isn't well as far as vitality usage. Burden adjusting has unevenly flowed, so all these lead to a poor relentlessness period.

NDBC Protocol: The proposed NDBC , has been intended to improve the lifetime of heterogeneous WSNs. In this paper, the makers have been utilized two sorts of SNs, for instance, advanced and move centres. Advance canters are having more essentialness than hand-off canter points. The moved canters are picked as CH dependent on its imperativeness and canter degree in the framework. NDBC helped with decreasing the correspondence cost among SNs utilized for transmitting and enduring the messages for CH affirmation.

VoGC Protocol: It is used the systems for casting a ballot and clustering to convey an energy gainful and secure limitation of the SNs as opposed to using a conventional grouping procedure. The reason for the VoGC technique is to reduce computational costs.

BARC Protocol: It incorporates with additional factor to utilize the energy efficiently. It rotates the CH to achieve the battery recovery scheme also it introduces a trust factor to gauge the reliability of CHs. The core difference between BARC and other existing protocols is the adoption of Z-MAC protocol which helps to enhance the network lifetime with any rigid constraint like other algorithms.

E-DEEC Protocol: It has been implemented on three types of the node to increase the heterogeneity and network lifetime. It is an advanced version of the E-DEEC protocol. The three types of nodes are advanced-nodes, relay- nodes, and super-nodes. Here, three different probability function has been defined for these three types of nodes.
So, according to the average energy of the network, the most suitable CH can be selected by using any one of the three probability functions

ELE Protocol: It is a probabilistic approach had been discussed. Here, the probability has been calculated based on the ratio between residual energy of each SN and the reaming residual energy of the sensor network. The primary difference in ELE is the data transmission process which uses a 2-level hierarchy, unlike other clustering protocols.

PRODUCE Protocol: The authors have been proposed a randomized and distributed clustering protocol which consists of unequal clusters. Here, the distance between CH and BS has been considered which brings two possibilities of communication such as; inter-cluster or intra-cluster. If the distance between CH and BS is less, then the CH can participate in the inter-cluster communication and if the distance is more, then probably the CH will participate in intra-cluster communication. This mechanism helps to avoid signal attenuation and more energy.

Abbreviations	Protocols
I-LEACH	Improved LEACH Protocol
IB-LEACH	Intra-Balanced LEACH Protocol
ECLCM	Energy Consumption and Lifetime analysis in Clustered Multi-hop Protocol
ECBDA	Energy-Efficient Cluster- Based Data Aggregation Protocol
DCEBC	Density Control Energy Balanced Clustering Protocol
FEED	Fault-Tolerant Energy- Efficient Distributed Protocol
LBC	Location-Based Clustering Protocol
NDBC	Node Degree Based Clustering Protocol
VoGC	Voting-On-Grid Protocol
BARC	Battery Aware Reliable Clustering Protocol
EDBC	Energy and Distance-Based Clustering Protocol
DCLB	Distributed Clustering Algorithms with Load Balancing Protocol
EECSIA	Energy Efficient Clustering Scheme with Self-organized ID Assignment Protocol
VAP-E	Virtual Area Partition Protocol
UMCA	Unequal Multiple Hops Clustering Protocol
DMCC	Distributed Multi-competitive Clustering Approach Protocol
DUCF	Distributed Load Balancing Unequal Clustering Protocol
MEDC	Mutual Exclusive Distributive Clustering Protocol
TSUC	Two-Step Uniform Clustering Algorithm Protocol
HSR	Hierarchical State Routing Protocol
EDBC	Energy and Distance-Based Clustering Protocol

DCLB	Distributed Clustering Algorithms with Load Balancing Protocol
EECSIA	Energy Efficient Clustering Scheme with Self-organized ID Assignment Protocol
VAP-E	Virtual Area Partition Protocol
UMCA	Unequal Multiple Hops Clustering Protocol
DMCC	Distributed Multi-competitive Clustering Approach Protocol
DUCF	Distributed Load Balancing Unequal Clustering protocol
MEDC	Mutual Exclusive Distributive Clustering Protocol
TSUC	Two-Step Uniform Clustering Algorithm Protocol
HSR	Hierarchical State Routing Protocol

Table (1) Summary of different clustering & Routing protocols

VI. Conclusion

Clustering and cluster head selection is one of the key research issues in the Wireless Sensor Network. In this paper, different CH selection algorithms are discussed in the present scenario. Most of the present CH selection mechanism focuses on reducing energy consumption by considering the residual energy of the sensor nodes. Throughput is an important aspect that is ignored in most of the proposed mechanisms. Future works will aim to develop a routing algorithm more efficient by considering more factors in the fitness function like energy balancing. An algorithm that works for heterogeneous WSN can also be developed. The optimization can also be improved by using hybrid optimization techniques to increase the search efficiency in order to converge at optimal solutions quickly. In the future, the selection of CH can be improved by using fuzzy algorithms and bio algorithms.

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