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A Review on Energy Efficient Clustering Techniques in WSN

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Abstract— Energy saving to prolong the network life is one of the major design issue while developing a new routing protocol for wireless sensor networks(WSNs). Clustering is key mechanism in large multi-hop wireless sensor networks for obtaining scalability, reducing energy consumptions and increase the life time of network to achieve better network performance. In literature various clustering approaches are proposed. In this article we present a survey on different energy efficiency clustering techniques and working of few of them and distinguish them according to operational mode and state of clustering.

Keywords— Clustering, LEACH, LEACH-C, REACH-IN, HSA, EHSN, BPSN, (ACH) 2 and RaSMaLai.

I. INTRODUCTION

A wireless sensor network (WSN) is an intelligent and low cost solution that enables the efficiency and reliability improvement of many industrial applications such as safety and security surveillance, home and building automation, and smart grids. The WSNs generally consist of a large number of sensor nodes which are low-power and small in size [3]. These sensor nodes can work as autonomous devices and be deployed in various types of environments. However, there are many challenges to bring the WSNs into real-life applications. One of the main concerns when developing the WSNs is to extend their lifetime .In many applications, a sensor node is powered by a finite energy source such as a battery or a super capacitor that restricts the WSNs' lifetime. The renewable energy sources like solar or wind have been investigated and integrated with the sensor nodes recently for longer operation [11]. However, the intermittent nature of these sources still has a significant effect on the network performance. Therefore, energy consumption of the WSNs needs to be taken into account when planning the network operation.

Cluster-based routing protocols are well-known techniques that enable the operation of WSNs to be highly energy-efficient. They also have special advantages related to scalability as well as efficient communication. The basic principle of a cluster-based protocol is to organize the sensor nodes into groups called clusters. In each cluster, a node is selected as the cluster head (CH) that has the responsibility to collect data from other cluster members, aggregate, and forward the compact information to a base station (BS). By using this principle, it is able to reduce the amount of data transferred within the network, thus energy saving is achieved.

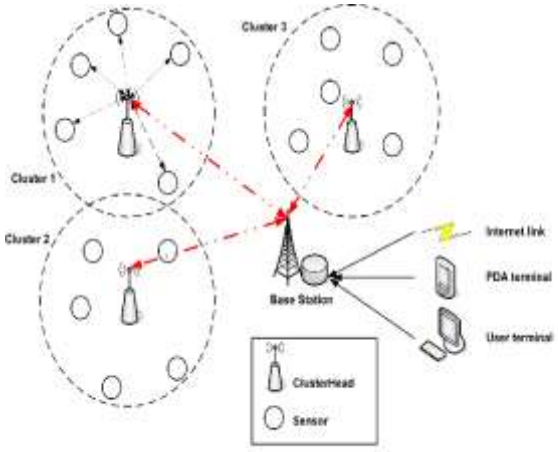

Figure 1 : General Sensor Network Architecture [11]

the clustering phenomenon is an essential part of the organizational structure with (figure 1) following components :

• **Sensor Node**: A Sensor nodes can take on multiple roles in a network, such as simple sensing; data storage; routing; and data processing.

• **Clusters**: Clusters are the organizational unit for WSNs.The dense nature of these networks requires the need for them to be broken down into clusters to simplify tasks such a communication.

• **Cluster heads**: Cluster heads are the organization leader of a cluster. They often are required to organize activities in the cluster

• **Base Station**: The base station is at the upper level of the hierarchical WSN. It provides the communication link between the sensor network and the end-user.

• **End User**: The data in a sensor network can be used for a wide-range of applications.

The clustering phenomenon as we can see, plays an important role in not just organization of the network, but can dramatically affect network performance.

There are several key limitations in WSNs, that clustering schemes must consider:

• **Limited Energy**: The limited energy in sensor nodes must be considered as proper clustering can reduce the overall energy usage in a network.

• **Network Lifetime**: The energy limitation on nodes results in a limited network lifetime for nodes in a network.

• **Limited Abilities**: The small physical size and small amount of stored energy in a sensor node limits many of the abilities of nodes in terms of processing and communication abilities

• **Application Dependency**: When designing a clustering algorithm, application robustness must be considered as a good clustering algorithm should be able to adapt to a variety of application requirements [11].

Design attributes of clustering algorithms:

- Cost of clustering
- Selection of cluster head and clusters
- Real-Time operations
- Synchronization
- Data Aggregation
- Repair Mechanisms
- Quality of Services

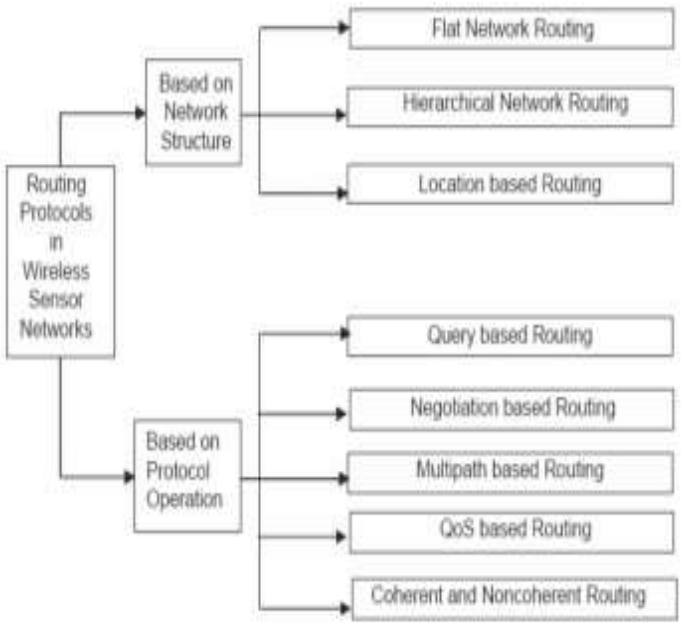

Figure 2 : Routing Protocols In WSN []

II. LITERATURE SURVEY

Jenq-ShiouLeu.et.al.[1] A suitable clustering algorithm for grouping sensor nodes can increase the energy efficiency of WSNs. However, clustering requires additional overhead, such as cluster head selection and assignment, and cluster construction. This paper proposes a new regional energy aware clustering method using isolated nodes for WSNs, called Regional Energy Aware Clustering with Isolated Nodes (REAC-IN). In REAC-IN, CHs are selected based on weight. Weight is determined according to the residual energy of each sensor and the regional average energy of all sensors in each cluster. Improperly designed distributed clustering algorithms can cause nodes to become isolated from CHs. Such isolated nodes communicate with the sink by consuming excess amount of energy. To prolong network lifetime, the regional average energy and the distance between sensors and the sink are used to determine whether the isolated node sends its data to a CH node in the previous round or to the sink. The simulation results of the current study revealed that REAC-IN outperforms other clustering algorithms. A WSN is a combination of wireless communication and sensor nodes. The network must be energy efficient and stable, and have a long lifetime. The REAC-IN protocol presented in this paper improves the cluster head selection process and solves the problem of node isolation. The results revealed that the performance of the algorithms used in REACIN to improve the lifetime and stability of a network is more favorable than that of the algorithms used in other protocols.

D. J. Dechene. et. al. [2] In this paper, we examine currently proposed clustering algorithms for Wireless Sensor Networks. We will briefly discuss the operations of these algorithms, as well as draw comparisons on the performance between the various schemes. The current state of proposed clustering protocols, specifically with respect to their power and reliability requirements. In wireless sensor networks, the energy limitations of nodes play a crucial role in designing any protocol for implementation. In addition Quality of Service metrics such as delay, data loss tolerance, and network lifetime expose reliability issues when designing recovery mechanisms for clustering schemes.

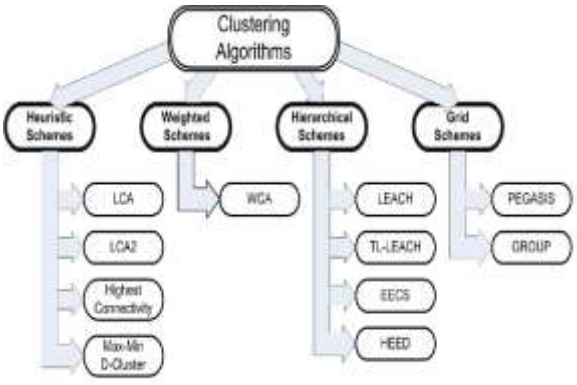

Figure 3: Classification of Proposed Clustering Schemes

DucChinh Hoang et. al. [3] a framework is proposed that is Based on a protocol using harmony search algorithm

(HSA), a music-based meta-heuristic optimization method, is designed and implemented in real time for the WSNs. It is expected to minimize the intracluster distances between the cluster members and their cluster heads (CHs) and optimize the energy distribution of the WSNs. The study of HSA cluster-based protocol is carried out in a real case where the WSNs equipped with the proposed protocol are deployed in an indoor environment to monitor the ambient temperature for fire detection. A comparison is made with the well-known cluster based protocols developed for WSNs such as low-energy adaptive clustering hierarchy-centralized (LEACH-C) and a cluster-based protocol using Fuzzy C-Means (FCM) clustering algorithm. Experimental results demonstrate that the proposed protocol using HAS can be realized in centralized cluster-based WSNs for safety and surveillance applications in building environments. The proposed protocol has been successfully developed and executed on a WSN test-bed for real-time fire detection in an indoor building environment. The experimental results show that, by using HSACP, the network lifetime is extended significantly when compared with LEACH-C and FCMCP. It is clear from the result that HSA can provide fast convergence with the best fitness value and a computational time of less than 10 ms is comparable with FCM. Thereby, it enables HSA to be applied for real-time configuration of the network. Additionally, the proposed frame work for designing clustering protocols can also be used as a tool for real-time operation to investigate other optimization algorithms for WSNs.

Amir Ehsani Zonouz. et. al. [4] it is essential to have a reliable routing protocol for this we first model the reliability of two different types of sensor nodes: 1) energy harvesting sensor nodes and 2) battery-powered sensor nodes. We then present wireless link reliability models for each type of sensor nodes , where effects of different parameters, such as battery life-time , shadowing, noise, and location uncertainty, are considered for analyzing the wireless link reliability. Based on the sensor node and wireless link reliability models, we compare the performance of different routing algorithms in terms of end-to-end path reliability and number of hops. In this work, we modeled the reliability of two different types of sensor nodes: energy harvesting sensor nodes (EHSNs) and battery-powered sensor nodes (BPSNs).We also presented wireless link failure models for each type of sensor nodes. Based on the node and link reliability models, we compared performance of different routing protocols including D, H, R, RH, and WH in terms of the average end-to-end path reliability. A dynamic routing approach that integrates the two best performance routing algorithms R and RH was further proposed. A new cost function was also defined to facilitate a fair and comprehensive comparison among these routing algorithms. In the future, we plan to investigate reliability analysis and design of hybrid WSNs which include both EHSN and BPSN within the same network.

M. Mehdi Afsar. et. al. [5] has mentioned that fault-tolerance is an essential characteristic which should be considered in the design level of such networks. On the other hand, WSNs are so energy constrained and through some solutions, like clustering the nodes, energy should be conserved as much as possible .In this paper, we propose Fault-Tolerant Service (FTS) for the clustered protocols. At the beginning, all the nodes are divided into some groups as clusters via the Energy-Efficient Distance-based Clustering (EEDC) protocol. Then, the FTS along by the main operation of the network, i.e. data gathering, is performed by the cluster-heads . The FTS is composed of three steps: fault detection, fault diagnosis and fault recovery. The main idea of fault detection in the FTS is message exchange. Redundancy is effectively utilized in this paper, where we propose a novel approach to elect the spare cluster-heads in which the elected spare cluster-heads are enough close to the cluster-heads. The simulation results and probabilistic analysis have confirmed the effectiveness of the proposed FTS in maximizing their liability of the clustered sensor networks.

AbderrahimBenslimane. et. al. [6] the relative and physical localizability of WSN in a given time bound. We propose a new distributed and time bounded localization algorithm based on Multidimensional Scaling (MDS) method in WSN called D-MDS localization time algorithm. We compare the proposed algorithm to the existing algorithm based on the well known Trilateration method. The simulation results show that the proposed algorithm outperforms the existing approach based on Trilateration method in terms of the number of localized nodes in the network and the number of anchors required to physically localize the sensors.

Sk Kajal Arefin Imon et. al. [7] the author has proposed a tree structure rooted at the sink is defined. Depending on various factors, including the WSN topology and the availability of resources, the energy consumption of nodes in different paths of the data collection tree may vary largely, thus affecting the overall network lifetime. This paper addresses the problem of lifetime maximization of WSNs based on data collection trees. we propose a novel and efficient algorithm, called Randomized Switching for Maximizing Lifetime (RaSMaLai), that aims at extending the lifetime of WSNs through load balancing. Given an initial data collection tree, RaSMaLai randomly switches some sensor nodes from their original paths to other paths with lower load. We prove that, under appropriate settings of the operating parameters, RaSMaLai converges with a low time complexity. Based on the concept of bounded balanced trees, our algorithm randomly switches the data forwarding paths of nodes. We have provided a simple yet effective switching strategy that results in a fast convergence. We have also presented a distribute implementation of our scheme that has a low overhead. An extensive study through both simulations and experiments on a real WSN test confirmed that our approach can significantly increase the network lifetime with a lower time complexity than the current state of the art in a wide range of operating conditions.

Ahmad El Assaf. et. al. [8] , we propose a novel range-free localization algorithm tailored for anisotropic WSNs. Using the proposed algorithm, each regular node estimates its distances only to reliable anchors. The latter are properly chosen following anew reliable anchor selection strategy

that ensures an accurate distance estimation thereby making our localization algorithm more precise.Using the proposed algorithm, each regular or position unaware node estimates its distances only to reliable anchors or position-aware nodes. The latter are properly chosen following anew reliable anchor selection strategy that ensures an accurate distance estimation making thereby our localization algorithm more precise. Indeed, simulations suggest that it outperforms the best representative range-free localization algorithms currently available in the literature in terms of accuracy. In this paper, a novel range-free localization algorithm tailored for AWSNs is developed where each regular node estimates its distances only to reliable anchors. The latter are properly chosen to ensure an accurate regular-to-anchor nodes distance estimation thereby making our localization algorithm more precise. Simulations confirm indeed that it out performs the best representative range-free localization algorithms currently available in the literature in terms of accuracy.

Ashfaq Ahmad. et. al. [9] Regarding energy efficiency in wireless sensor networks (WSNs), routing protocols are engaged in a playful manner suggesting a consciousness of high value. In this paper, we present away cluster heads (CHs) with adaptive clustering habit (*(ACH)*2) scheme for WSNs. Our proposed scheme increases the stability period, network lifetime, and throughput of the WSN. The beauty of our proposed scheme is its away CHs formation, and free association mechanisms. The *(ACH)*2 controls the CHs' election and selection in such a way that uniform load on CHs is ensured. On the other hand, free association mechanism removes back transmissions. Thus, the scheme operations minimize the over all energy consumption of the network. In subject to throughput maximization, a linear programming-based mathematical formulation is carried out in which the induced subproblem of bandwidth allocation is solved by mixed-bias resource allocation scheme. We implement *(ACH)*2 scheme, by varying node density and initial energy of nodes in homogeneous, heterogeneous, reactive, and proactive simulation environments. Results justify its applicability.

Davood Izadi. et. al. [10] Sensing coverage is a fundamental design problem in wireless sensor networks (WSNs). This is because there is always a possibility that the sensor nodes may function incorrectly due to a number of reasons, such as failure, power, or noise instability, which negatively influences the coverage of the WSNs. In order to address this problem, we propose a fuzzy based self-healing coverage scheme for randomly deployed mobile sensor nodes. The proposed scheme determines the uncovered sensing areas and then selects the best mobile nodes to be moved to minimize the coverage hole. In addition, it distributes the sensor nodes uniformly considering Euclidean distance and coverage redundancy among the mobile nodes. We have performed an extensive performance analysis of the proposed scheme. The results of the experiment show that the proposed scheme outperforms the existing approaches.

III. PROPOSED WORK

The proposed system will work on multipath routing. This system will contain static and dynamic network topologies. The traditional LEACH routing algorithm will be compared with enhanced hierarchal routing algorithm on the basis of parameters such as throughput time, cluster head selection, load balancing, and energy consumption in heterogeneous wireless sensor networ . The performance of network is examined by using MATLAB.

IV. CONCLUSION

We have discussed an overview of the existing energy efficiency techniques in clustering environment. Finally, it is concluded from the literature studies that most of in this work, we modeled the performances of protocols for head selection by LEACH ,REAC-IN and other hierarchal techniques in static network in small areas. In addition the reliability study of two different types of sensor nodes: energy harvesting sensor nodes (EHSNs) and battery-powered sensor nodes (BPSNs). We also presented wireless link failure models for each type of sensor nodes. In these models, we consider different parameters, such as cluster formation ,selection of head ,regional energy source for isolated nodes ,battery life-time, drain of energy , noise and location uncertainty on wireless link reliability all the techniques work better in good pre designed environment conditions but performance is decreasing in frequently changing requests and in very large network coverage. Since the selection of the right procedure of removing problems occurred in both techniques plays an important role, it is important to experiment and a hybrid technique need to be developed which uses both techniques to get positive result.

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