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HYBRID PROTOCOL FOR ENERGY EFFICIENT ROUTING USING WIRELESS SENSOR NETWORKS

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Abstract

A Wireless sensor network can be defined as a network of devices that can communicate the information gathered from a monitored field through wireless links. The data is forwarded through multiple nodes, and with a gateway, the data is connected to other networks like wireless Ethernet. WSN is a wireless network that consists of base stations and numbers of nodes (wireless sensors).These networks are used to monitor physical or environmental conditions like sound, pressure, temperature and co-operatively pass data through the network to a main location. The primary contribution of this research paper is to develop efficient routing protocols for Wireless sensor network with a special focus on the following three factors: energy efficiency routing with wireless IOT sensor network, clustering implementation, next generation sensor network with fuzzy logic.

1. Introduction

Wireless sensor networks (WSNs) have been receiving surpassing attention as an emerging application area for ad hoc networks. WSNs composed of a number of sensor nodes, which is low-power, low-cost, and multifunctional, with wireless computation and communications capabilities. These sensors communicate via a wireless medium within a short distance and cooperate to perform a common task, such as environment monitoring, target tracking, and industrial process control [1]. The thought is to use a collection of tiny, cheap, stationary sensors to sense physical characteristics about the surrounding environment and then transmit it to an associated sink node [2]. However, the variety in the applications of the WSNs, the main duty of the WSNs is to sense data, process the data, and transmit these data back to specific node (base station or sink).

Routing protocol specifies information that enables the nodes to select routes between them [4]. The objective behind routing in WSNs is to transmit data from a sensor node to a known destination sensor node. Achieving this objective demands to set up paths between sensor nodes and the destination by developing of the effective routing protocol [5]. The network resources' limitations such as energy, storage, and bandwidth, communication link failures, multidimensional optimization problems, and several

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network constraints and requirements make the routing protocols designing for WSNs are extremely challenging. Routing design is closely related to the system architecture mode [6].

A Wireless Sensor Network (WSN) is an accumulation of sensor nodes, which coordinate to perform a specific task. The sensor nodes are usually randomly deployed in an unattended environment [7]. They perform sensing and work together to monitor the environment and provide high-quality information. Each sensor node takes the decision based on sensed information, its expertise in processing, ability to communicate and energy resources. Sensor nodes sense the environment and then send that information to the sink as shown in Figure 1.

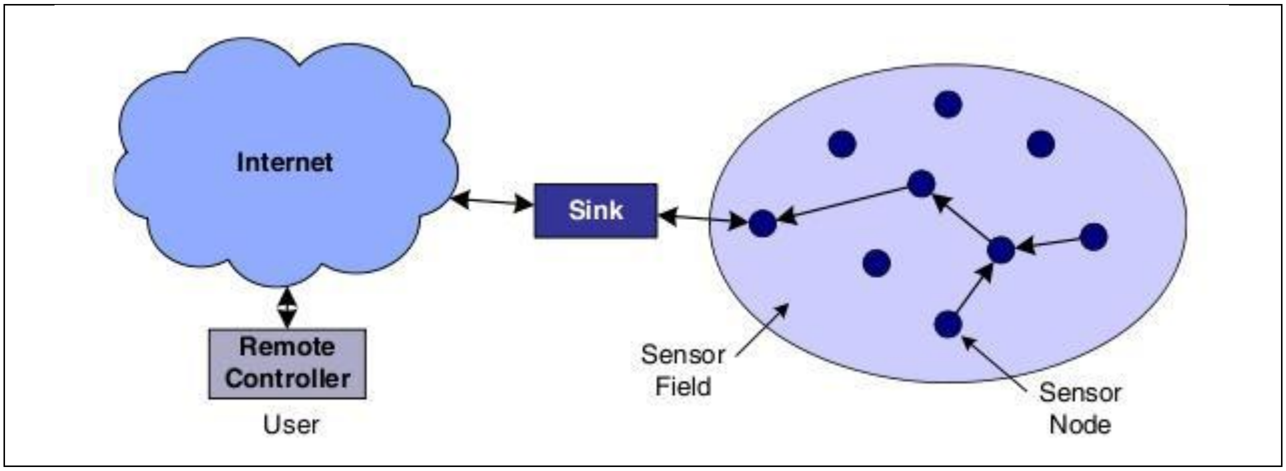

Figure 1: WSN architecture [4]

Wireless sensor networks, just like wireless ad-hoc networks are dynamic in nature due to the frequently changing wireless links and thus network connectivity. In addition, the topology of WSNs changes when the nodes die out or join the network [8]. Further, WSNs and wireless ad-hoc networks show similarity in communication as well as WSNs communication conventionally happens in an ad-hoc manner.

One of the creating frameworks organization rules is the opportunity among the real world and the digital world is the IoT, wherein, clever articles talk with each other, Data is collected and various solicits of customers are then acknowledged by the differently addressed data. The essentialness of capable designs for the IoT is a hectic issue as the IoT ends up being progressively astounding a direct result of its broad scales the present strategies of remote sensor frameworks can't be associated in context of IoT. Achieving the green sorted out IoT, the underlying study watches out for imperativeness profitability affairs by developing a distinct sending plan [9]. The underlying study presents a different leveled orchestrate structure

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- Method for the essentialness capable IoT;
- Base imperativeness usage transmission figuring to execute the perfect model.

The reenactment outcomes demonstrate that the improved arrangement is much imperativeness beneficial and versatile as compared to the ordinary WSN plans and consequently it will in general be executed for capable correspondence in the IoT. Extending enthusiasm for remote correspondence has gotten an enormous interest in a couple of consistent application systems. In this field of remote correspondence, remote sensor frameworks are seen as the most reassuring response for checking the different sort of prohibitive essentials. These frameworks can be passed on adequately in antagonistic and perilous circumstances. Regardless, these frameworks are energized with a compelled battery limit therefore, organize lifetime is seen as a troublesome task in this field. To vanquish this issue of framework lifetime, we develop an imperativeness procuring and essentialness the administrator's show which is known as Energy Aware Buffer Management Routing show (EABMRP), to improve the framework lifetime [10].

Essentialness viability and framework lifetime related issues are seen as a troublesome errand for the examination arranges which can improve the framework lifetime execution. A couple of plans are accessible in current state which relies upon the imperativeness profitable directing show for hauling out the framework lifetime. The essentialness careful based plans are regularly arranged into two essential groupings as level coordinating and different leveled guiding show.[11] As shown by the dimension coordinating plans, each sensor center accept a comparative employment in the entire framework while in the dynamic show [12], various gatherings are molded and pack heads (CH) are picked to propel the data packages to the sink center point.[13] Continuous examinations exhibit that the different leveled coordinating based plans outfit better execution when differentiated and the dimension controlling shows.

2. Literature Review

The unique characteristics and wide application of WSNs have motivated researchers to propose various approaches and algorithms to optimize the performance of sensor nodes in networks, concerning many metrics (e.g., latency, throughput, energy cost, scalability, average energy consumption, end-to-end delay). Most of the approaches that have been used in the literature are based on the existing protocol [14], and attempts have been made to improve on them. Performance evaluation, for some of these proposed protocols, is undertaken using simulations, while others are implemented through test beds. Some of the outstanding approaches which have been proposed by different authors (as reported in the literature) to minimize energy consumption in WSNs are presented below. The strengths and weaknesses of each approach are highlighted. In the next sections, a review of those approaches is presented fewer than three subsections: hierarchical energy-aware routing protocols, heterogeneous routing protocols, and ACO routing protocols. In order to conserve the limited energy that is available to sensor nodes and extend the network the lifetime,

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they are usually organized into different clusters in layers to form a hierarchical clustering network [15]. In each cluster, at least a node is selected as a cluster head (CH), depending on the protocol used and the size of the network. The nodes are responsible for collecting sensed data from member nodes, aggregate, and forward them to a base station via multi-hop communication. LEACH was the first unique and outstanding protocol proposed for clustering sensor nodes in WSNs, based on the hierarchical routing technique [16]. Most other protocols proposed thereafter (for hierarchical routing) have used the LEACH protocol as a benchmark. However, this protocol has several shortcomings: (1) the sensor nodes selected as CHs in LEACH are not evenly distributed within the network; thus, nodes that are far from the CH transmit through long distances and more energy is consumed during the transmission; and (2) the CH selection method is based on probability, which may lead to an increase in overhead when selecting new CHs and may result in an increase in energy consumption. Wang et al. [17] proposed a novel energy-aware hierarchical cluster-based (NEAHC) routing protocol for WSNs. The goals of their work are to minimize the total energy consumption and to ensure the load balancing of energy consumption between sensor nodes. They developed an algorithm for the proposed scheme, which is divided into two phases: cluster setup phase and the steady-state phase. They model the relay node as a nonlinear programming problem and use the property of convex function to determine the optimal solution. The proposed scheme was evaluated through simulations. They compared their approach with two other related protocols. The proposed scheme minimizes communication cost and direct data transfer by nodes close to base station prolongs the network lifetime compared with selected related protocols. However, the network area and the number of nodes they used for their simulation are small. There is a high possibility for this approach not to perform better if the network size is large, for instance, if the number of nodes is 500 or more. Xie et al. [18] proposed energy-efficient routing for mobile data collectors in WSNs with obstacles, by dividing the network region into grid cells with the same size. Tis approach provides a convenient construction of the spanning graph, using the line sweep approach. The graph is composed of cells, which include the shortest search route for the mobile data collector (MDC). Tis method represents a heuristic tour-planning algorithm based on a complete graph. Performance evaluation of this approach shows that it is able to successfully is patch MDC and extend the lifetime of the WSNs. However, only one MDC was used to evaluate this approach, when it should be evaluated using many collectors. Ayoub et al. [19] proposed a cluster-based multi-hop advanced heterogeneity-aware energy efficient (MAHEE) protocol, which reduces the energy consumption of sensor nodes by choosing optimal CHs, thus allowing multi-hop inter-cluster communication using equal amounts of energy among all nodes. Te algorithm is based on a clustering path planning algorithm for WSNs. In the proposed method, a node with higher energy is selected as a CH from among other nodes in the network, which achieves load balancing among the other nodes. MAHEE consists of two types of sensor nodes—normal and advance—which are equipped with different initial energy

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values. Tis helps to select a suitable CH based on the residual energy and distance from a base station. Simulation results show that the proposed approach performs better than existing state-of-the-art heterogeneous routing protocols and improves network stability and lifetime. However, there is a high possibility that the CHs which are selected are not randomly distributed within the network. Thus, sensor nodes that are far from the CHs will transmit across a long distance and dissipate more energy. Qureshi et al. [20] developed the Balanced Energy-Efficient Network-Integrated Super Heterogeneous (BEENISH) protocol. Te protocol is an extension of (DEEC) in [21], in terms of choosing a CH based on the residual energy level of the nodes, with respect to the average energy of the network. BEENISH consists of four types of sensor nodes: normal, advance, super, and ultra-super nodes, each with a different energy level. The authors used the concept in to divide the network into different clusters, in which ultra-super nodes have a higher probability of being selected as CHs than other types of nodes (because they are high-energy nodes). Simulation results show that this protocol performs better than previous clustering protocols in heterogeneous WSNs. However, the performance of the protocol is only based on two metrics—the number of alive nodes and data packets—which is not enough to determine how efficient and reliable the proposed protocol is, compared to other related heterogeneous protocols. An efficient CH selection was proposed to extend the network lifetime, through an approach called Energy-Dependent Cluster Formation in heterogeneous WSNs (EDCF) [22]. The authors employ a clustering process to reduce energy consumption, to extend the network lifetime. The method of CH selection starts with the generation of a random number between zero and one. An individual sensor node that wants to become a CH generates that number and checks it against its threshold function. If the value of the number generated is less than the threshold value, the node is selected as the CH for that round. Otherwise, the same process is repeated by the next node, to become the CH. Te results of the experiment show that the proposed protocol is better at prolonging the network life span than related heterogeneous protocols. However, the proposed scheme is similar to the approach in, which means it will have the same weaknesses. Fog-based energy-efficient routing protocol for WSNs (P-SEP) is proposed in. The proposed scheme uses PEGASIS-based routing of fog nodes (FECR) and ACO-based 26 routing of fog nodes (FEAR) algorithms for the heterogeneous WSN. The selection of cluster heads (CHs) is based on probability function considering initial energy and current energy of sensor nodes in the network. The CHs transmit their data packets to the closest fog node which further processes and forward its data to the cloud using FECR and FEAR algorithms. The results of the simulation show that the approach decreases energy consumption and increases network lifetime. However, the authors claimed that either a normal node or an advanced node can be selected as a CH. If two or more normal nodes are consecutively selected as CHs, while advanced nodes remain as members of a cluster. An energy hole will be created and resulted in the loss of data packets being transmitted in the network. Mohajerani and Gharavian [23] proposed a life-time-aware routing algorithm for WSNs (LTAWSN). A unique

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pheromone function was derived to integrate hops and energy consumption into the routing choice. The main aim of this approach is to optimize the energy consumption of the sensor nodes in WSNs. LTAWSN is better at minimizing energy consumption and extending the network lifetime than related routing algorithms for WSNs. The proposed a unique routing algorithm called RABACO, based on the position information and search direction in ACO. Tis improves the network routing algorithm by considering the residual energy, heuristic function, sensor node communication distance, searching range, and transmission direction from the source node to the destination node. Simulation results show that the proposed algorithm minimizes the average energy consumption and prolongs the network lifetime.

3. Applications of WSN

As the Internet has brought changes in our lives, it is a future vision that WSN will further influence our daily lifestyle.

The applications of sensor network can be distinguished in two board categories, namely monitoring space and monitoring targets. Applications such as habitat monitoring, environment monitoring, military surveillance, intelligent security systems, and precision agriculture fall under monitoring space. Whereas the applications like object tracking, terrain mapping and structural monitoring come under monitoring targets. Some of the significant applications of WSN are described below

A. Environmental Monitoring

One of the major applications of WSN is in monitoring the behavior and phenomena of the environment. WSN is deployed to gather data from a specific geographic region.

B. Security Applications

WSN is often used for infrastructure security and home security. Smaller versions of such security systems are becoming more and more popular and are usually referred to as a home security system. Key public infrastructures, such as nuclear power plants etc. can be secured by integrating networks of video, acoustic and other sensors.

C. Military Applications

WSN research initially started in the military domain. In this domain, there are some wide categories of usage. For example, WSNs can be utilized to track enemy vehicle, land mine's detection, wireless communication between tanks and fighter planes, monitoring activities at country borders and soldier-less security by a robot equipped with sensors, to name a few.

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Table 1: Comparison of Traditional Networks and Wireless Sensor Networks

Traditional Networks	Wireless Sensor Networks
General-purpose design; serves many applications	Single-purpose design; serves one specific application
Typical primary design concerns are network performance and latencies; energy is not a primary concern	Energy is the main constraint in designing node and network components
Networks are designed and engineered according to plans	Deployment, network structure, and resource use are often done in an ad hoc manner (without planning)
Devices and networks operate in controlled and mild environments	Sensor networks often operate in harsh environments
Maintenance and repair are common and networks are easily accessible	Physical access to sensor nodes is often difficult or sometimes ever impossible
Component failure is addressed through maintenance and repair	Component failure is expected and addressed even in the design stage of the network
Obtaining global network knowledge is both feasible and possible because of centralized management	Most decisions are made localized without the support of a central manager

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Table 2: Comparison of Traditional Networks and Wireless Sensor Networks

Parameters	**Wireless Multimedia Sensor Networks**	**Wireless Sensor Networks**
Node Size	Small	Very Small
Node Density	Medium	High
Node Coverage area	Medium (metres)	Low (metres)
Data Type	Multimedia, like still image, video streaming and voice	Scalar, like temperature, humidity, and fire sensor, among others
Bandwidth requirement	Medium	Low
Congestion Control Algorithm requirement	High	Low
Power Consumption	Low	Very Low

4. Overview of Internet of Things (IoT) for WSN

Research and technology advances continuously extend and diversify wireless sensor network (WSN) applicability. As a consequence, WSN designers faced an increasing range of applications and requirements under rising cost and time pressures since the Internet of Things (IoT) paradigm was coined more than 15 years ago [24]. “Typical” requirements for WSN hardware and software are increasingly difficult to define [25] because they continuously adapt to very diverse application requirements and operating conditions at a rate which does not seem slowed down by standardization efforts or proprietary API proposals.

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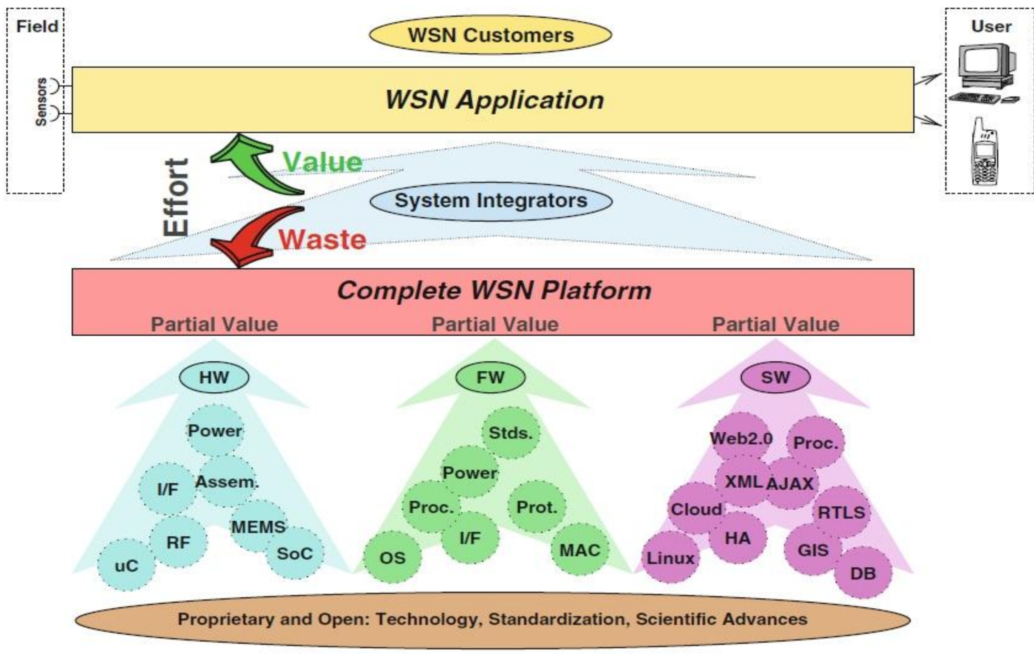

Figure 2: Value flow for a WSN application and platform

Moreover, although WSN solutions are used for numerous applications, the implementations generally differ under various aspects which significantly reduce the economies of scale. Consequently, both hardware and software of WSN solutions are often application-specific prototypes that carry significant non-recurrent engineering costs and risks (e.g., reliability, optimization, and development time). Additionally, for various practical reasons WSN deployments are typically developed at lower abstraction levels, which can have two significant undesirable effects. First, this can divert an important development effort from application logic implementation, as shown in Figure 2, which increases development time and cost, and generally decreases reliability. Second, lower abstraction level development often requires competencies that are seldom found among application domain experts, which can lead to higher development cost and more reluctant adoption of WSN-based solutions. At the same time, the flow should simplify the integration and coexistence of tools and technologies from different vendors and projects. Most existing WSN solutions efficiently address specific vertical application domains for various reasons, and not the least because building and maintaining a complete and flexible platform often requires a broad range of competencies and can be very costly. This development flow aims to reduce the effort and cost by:

Being accessible to application domain experts

This helps spreading the use of WSN-based solutions to more application domains, while often reducing development cost and time.

Focusing design effort mostly on application logic

WSN technology is based on several engineering disciplines. WSN development tools and flows should provide a good separation between the underlying technological details and the application developer.

Optimizing implementations for cost, power, and reliability

This is especially important for the quality of service of the WSN application over its lifetime. Moreover, they implicitly reduce the recurrent cost for both node production and their field maintenance.

Maintainability of the complete development flow

This is tightly related to tool integration above. The tools should be easy to integrate in the development platform, e.g., in terms of semantics, interfaces, and data formats, in order to simplify the upgrade or replacement of existing tools or the addition of new ones.

Simplifying the comparison of design results

The platform should simplify playing *what if* scenarios, in which elements change, e.g., a tool in the development flow, the target node, or the embedded operating system (OS). Since the rest of the platform remains the same, it simplifies the observation of the effects of the change. This should allow a closer reproduction of research results and the comparison between different research tools or approaches. Also, this should allow selecting the most effective solution for a given WSN application.

Integrating existing or new tools and technologies

Tool development can be often effort-intensive, hence reusing existing tools, either proprietary or public domain ones, is economical. Besides, the tools may be customized, e.g., for specific hardware or for specific application domains. Effort and cost issues are amplified by the fast evolution of WSN technology.

Facilitating research permeation in commercial applications

This is tightly related with the above point. The benefits of new research results can be compared with the existing flows by playing adequate *what if* scenarios. Moreover, research tools are already integrated in the platform simplifying their porting to existing production flows based on the platform.

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Building business models

Last but not least, the purpose of the platform is to be useful for real WSN applications by providing value through vendor- or application-specific customizations of the general purpose flow. Thus, on the one hand, the platform should allow the integration of proprietary tools or protected intellectual property (IP) blocks, e.g., simulation models or functional code. On the other hand, the platform should simplify the contribution of code (custom or general purpose), flows, or other developments made by commercial users.

5. Proposed System

The proposed show (TEDD) makes the tree in the framework. There are two orders of the centers in the tree: one is the exchange center point (RN), and the other is the non-hand-off center [26] (non-RN). The hand-off center point is skilled to giveaway the data from the centers to its next exchange center point. The non-hand-off centers can simply pass on through a hand-off center. [27] Thusly, it is a unidirectional correspondence. In any case, the correspondence is bi-directional between two exchanges centers [28]. The tree topology alters when action of the center point alters from a hand-off to non-hand-off or from non-hand-off to a trade center. To turn the responsibility of the hand-off each inside's holding up essentialness is taken into consideration. [29]

The sink is flexible and accumulates the data from the source center points via the door center. The entry center might be an exchange center or a non-hand-off center [30]. The sink picks the entry center reliant on the criteria referenced. The sink at times transmits a little reference point to make the affiliation blasting at the creases with the portal center [31]. If the sink moves out of the extent of the present section center point, by then it picks another center point as the door center point. The turn of the entryway center can vanquish the issue of the imperativeness opening. The proposed show contains diverse stages, for instance, neighbor disclosure, tree advancement and exchange center point decision, and data transmission. [32]

6. Methodology

Information: n number of sensor hubs arbitrarily conveyed.

Yield: One essential and substitute ways from the source to the sink.

```
sink ← Primary;
rehash
in the event that (hub == Primary) at that point
Discover Primary Path();
Find Alternate Path();
else in the event that (hub == Exchange) at that point
Find Primary Path();
end if until (next hub 6= Source)
methodology Discover Primary Path()
```

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on the off chance that (hub == Primary) at that point
Communicate Essential;
pick the following hub to turn into the essential hub by utilizing the conditions 2.9 and 2.10;
next hub ← Essential;
unicast the insinuation message to the following hub;
end if
in the event that (hub == Substitute) at that point
Communicate Substitute;
pick the following hub by utilizing the conditions 2.9 and 2.10;
in the event that (next hub 6= P rimary) at that point
next hub ← Substitute;
unicast the hint message to the following hub;
end if
end if
end strategy
strategy FindAlternatePath()
on the off chance that (hub == essential) at that point
pick the following hub acknowledge essential by utilizing the conditions 2.9 and 2.10;
next hub ← Interchange;
unicast the implication message to the following hub;
end if
end strategy

7. Result and Analysis

The amount of CHs, exchange centers and CCOs will rise with the extension in the scale as with the development in the proportion of the framework, so incalculable will be required to partner and keep up the pleasant method.[33]

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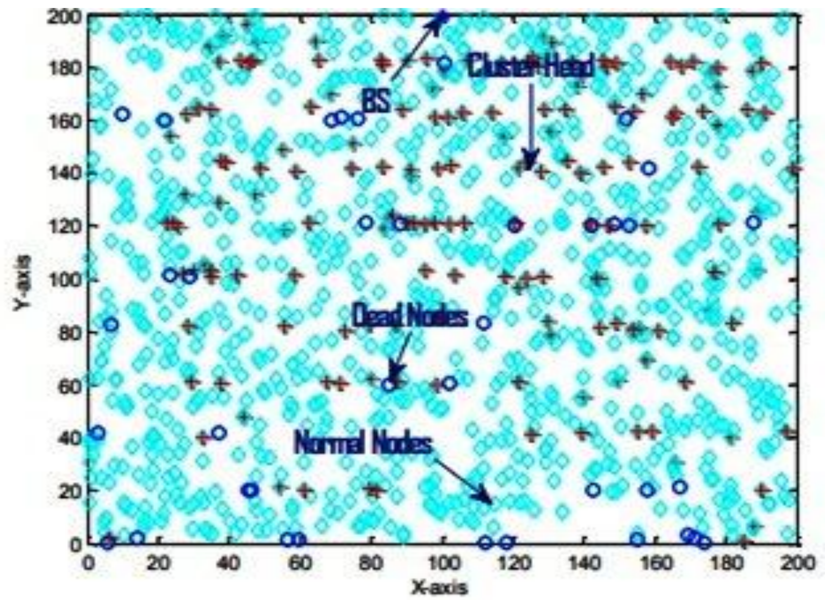

Figure 3: Graph Simulation after 200 rounds of data transmission

Right when the circumstance of the BS and diverse center points (CH, RN, CCO) is fixed, by then less imperativeness is used as there is no convincing motivation to investigate and over for these center points. [34] If the correspondence length of the center points is extended they can cover a broad region, and after that these centers can be reduced in number in each layer. [35]

To make it all the more strong, Figure 3 delineates the dead hub chart after 5000 rounds. After 500 rounds of information transmission, 90 hubs are dead in SEP, 113 in LEACH, 368 in ERP, 303 in hereditary HCR; 121 in 543 T-DDEC, MODLEACH, 14 in EESAA and 49 hubs in ME-CBCCP. After 1000 rounds of information transmission, SEP, LEACH, ERP, hereditary HCR, MODLEACH, T-DEEC and EESAA lost 459, 660, 493, 625, 535, 726, and 129 of their hubs, individually, yet just 73 hubs are dead in ME-CBCCP. This demonstrates ME-CBCCP is an ideal answer for a vitality productive IoT.

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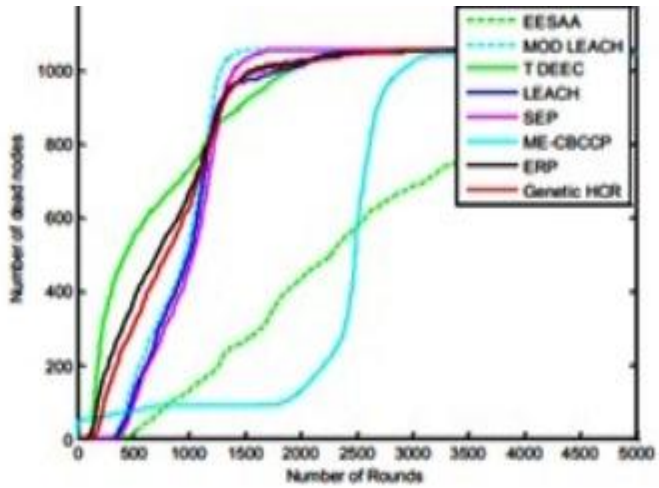

Figure 4: Network lifetime assessment (1000 nodes, with the help of a live node, 200 m^2)

Normal Control Packet Overhead

The sensor center transmits the control bundles to build the gathering district and deal with the sink flexibility [36]. The common essentialness use of control group with fluctuating sink speed for different shows is showed up in Figure 4. As the outcome appeared in the framework, the control pack overhead is less in the Proposed Strategy when stood apart from different shows.[37] In LBDD, an inline-center point stores the information from the source center. Right when that inline-center point gets the request, it sends the information to the sink. In figure 4 the sink's request has been overflowed into the gathering region, which causes an all-inclusive control bundle overhead. In the railroad appear, the rail improvement and station strategy is the one-time process. [38]

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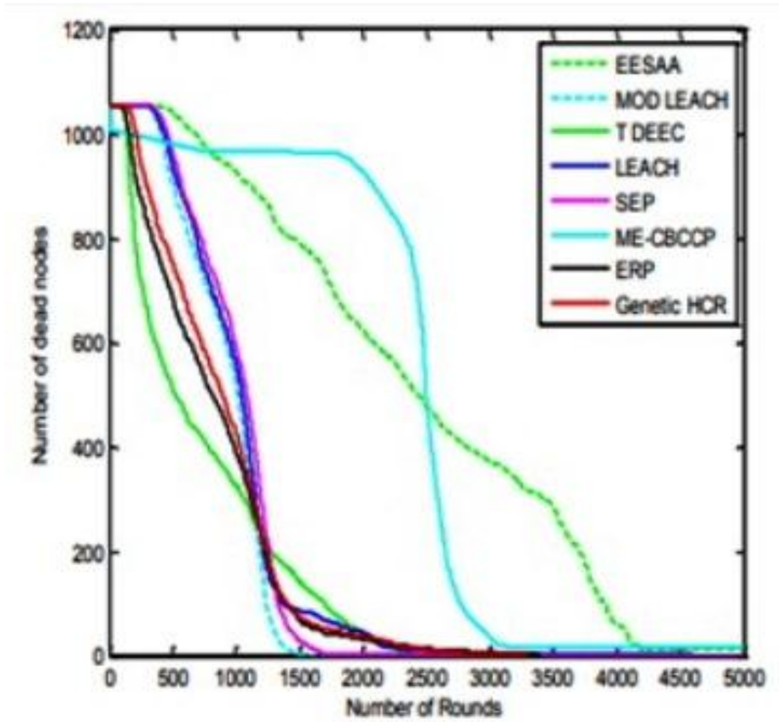

Figure 5: Network lifetime assessment (1000 nodes, the support of dead nodes in 200 m^2)

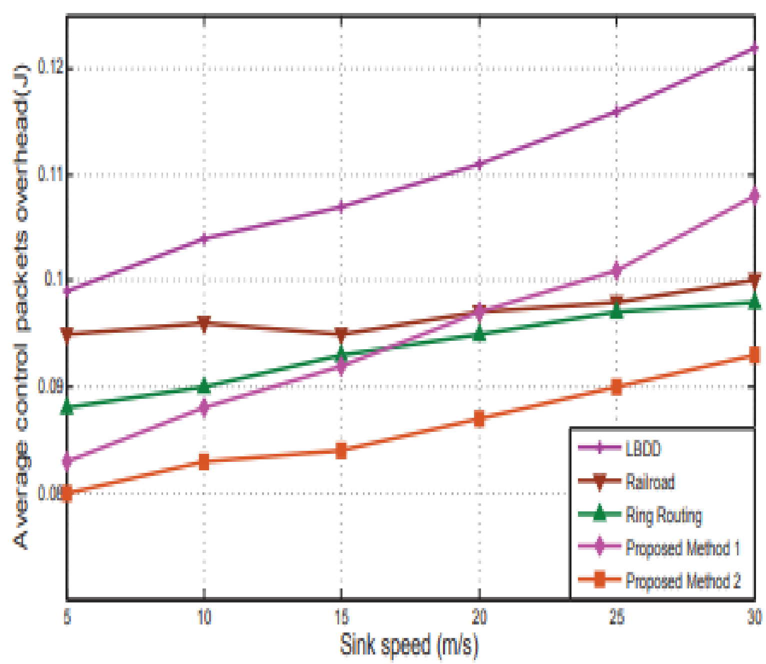

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Figure 6: Control Packet Overhead

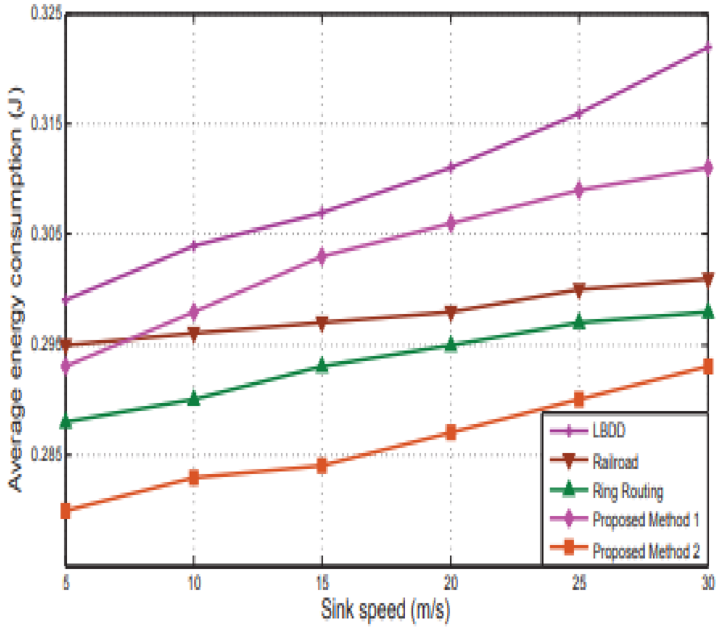

Figure 7: Average Energy Usage

In figure 7, the strategy of metadata amassing at station and recuperation of the sink region from the station requires the control pack exchange. In ring coordinating, all the ring center points store the zone of the sink [39]. So the recuperation of the sink zone is less complex. In any case, as the framework task propels, it requires the exchanging of control groups to fix the ring. [40] So the ring length increases, and along these lines, the division from the source or the sink causes greater essentialness usage.[41] The control packs are required to set the association according to the sink position. In any case, the Proposed Strategy 2 uses less control package overhead. It is in light of the fact that; the ordinary detachment between gathering locale and the source or the sink isn't actually extraordinary shows. [42]

8. Conclusion

Imperativeness capability plans have an enormous activity in structure up a gainful IoT. We have developed an updated answer for the issue of arrangement problems of objects in the use of a significance able and adaptable IoT. Straight forwardly off the bat, we gave the framework for the sending of the IoT which has flexibility features and makes it logically extensible. By at that point, considering the structure, an improvement plan which is obliged by the loads on remote associations and imperativeness use strengthen the strategy of a centrality proficient IoT. In end the ME-CBCCP estimation has been built dependent upon the bunching topology as a reaction for improvement issue. In this chapter, we have focused on imperativeness careful guiding show in remote sensor frameworks to improve the framework lifetime. As shown by the WSN model, essentialness usage in the midst of data collection, social occasion, and transmission prompts the degradation of framework lifetime which is a troublesome issue. Thusly, in this work, we revolve around framework lifetime subject to the imperativeness procuring system. To address this issue, a framework coordinating show is made using a help the board scheme which limits essentialness usage. Furthermore, a powerful gathering based model is moreover made to improve the framework lifetime.

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