Computers, Materials & Continua

Tech Science Press

DOI: 10.32604/cmc.2023.036275
Article

An Energy-Efficient Protocol for Internet of Things Based Wireless Sensor Networks

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Received: 23 September 2022; Accepted: 23 December 2022

Abstract: The performance of Wireless Sensor Networks (WSNs) is an important fragment of the Internet of Things (IoT), where the current WSN-built IoT network's sensor hubs are enticing due to their critical resources. By grouping hubs, a clustering convention offers a useful solution for ensuring energy-saving of hubs and Hybrid Media Access Control (HMAC) during the course of the organization. Nevertheless, current grouping standards suffer from issues with the grouping structure that impacts the exhibition of these conventions negatively. In this investigation, we recommend an Improved Energy-Proficient Algorithm (IEPA) for HMAC throughout the lifetime of the WSN-based IoT. Three consecutive segments are suggested. For the covering of adjusted clusters, an ideal number of clusters is determined first. Then, fair static clusters are shaped, based on an updated calculation for fluffy cluster heads, to reduce and adapt the energy use of the sensor hubs. Cluster heads (CHs) are, ultimately, selected in optimal locations, with the pivot of the cluster heads working among cluster members. Specifically, the proposed convention diminishes and balances the energy utilization of hubs by improving the grouping structure, where the IEPA is reasonable for systems that need a long time. The assessment results demonstrate that the IEPA performs better than existing conventions.

Keywords: Energy consumption; improved energy-proficient algorithm; internet of things; wireless sensor network

1 Introduction

Recently, a new and exciting area for the creation of novel types of applications has been made possible by the enhancement of remote sensor groupings in Wireless Sensor Networks (WSNs). WSNs are made up of countless tiny detecting hubs that monitor their present situation, measure vital information (using a chip), and send and receive processed information to/from other detecting hubs, as shown in Fig. 1.

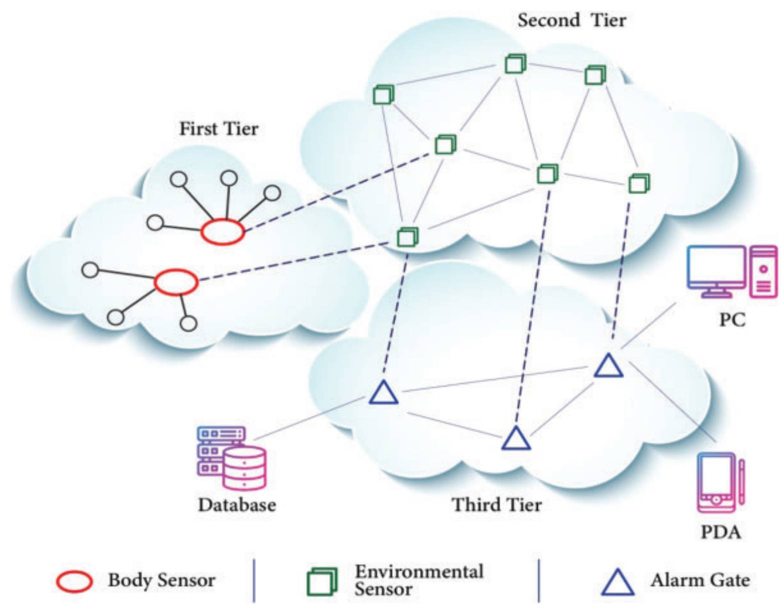

Figure 1: Architecture of a wireless sensor network

These detecting hubs, which are spread across the environment, are connected to sink hub integrated organizations or other detecting hubs by an organization. In integrated organizations, the sink collects sensor data for the end user to use. The sink is typically appropriate for using broadcasting, sending network strategy, and sending control data to implement hub detection. Similar to other organizations, three common plan challenges have a significant negative impact on the availability and profitability of the entire organization. These challenges include using network conventions to limit control and information bundles, choosing the best geography by placing hubs in the ideal locations, and sending a steering calculation that transmits information effectively through the organization from the root hub to the objective hub (s).

An energy-efficient protocol needs to accomplish many requirements, as follows:

Lower energy consumption: Since communication consumes the majority of a sensor's energy, longer sensor lifetimes immediately necessitate that this correspondence burns gradually over the available energy.

Compatible with multi-jump communication: Since energy use is proportional to distance squared, sensors are often placed at a safe distance from the sink; hence, it is preferred that sensors use other sensors as relays while communicating. The conveyance of hubs in the environment might be secondary or non-underlying. The former is used when there is no control over hubs after circulation, and their main duty is to monitor the environment, gauge the information, and build the organization by locating and forming relationships with their neighbors. In any event, the position of each hub (both detector and sink) is obvious in the aforementioned functionality.

Scalability: The communication convention should be reliable when it comes to creating and maintaining a network of sensors. When the organization's size increases, this convention should continue as usual.

Reliability: Solid information transmission in terms of parcel misfortune is one of the fundamental concerns to be taken into consideration to deliver efficiency in checking and control frameworks.

While endeavors to diminish energy utilization have covered various parts of WSNs, numerous significant issues remain:

- There is no overall methodology for deciding and advancing the energy devouring constituents of WSNs.
- Current methodologies center around one angle, and may stack energy utilization in different perspectives.
- Existing methodologies miss quantitative proportions of energy utilization of the whole organization.
- Most of the current methodologies are pertinent for explicit sensor networks with exceptional properties.

In this postulation, we tackle the initial two issues profoundly just as contacting the third one. Momentarily, we present another energy-driven design by parting the entire WSN framework into a couple of principle constituents.

The rest of the paper is organized as follows. An overview of related works and various requirements of the energy efficient protocol are presented In Section 2. A detailed statistical analysis, followed by a comparison between the Hybrid Media Access Control (HMAC), Polling Time-Division Multiple Access (PTDMA) and Improved Energy-Proficient Algorithm (IEPA) is presented in Section 3. In Section 4 we present our simulation parameters, and then an analysis of the results of our approach, discussing the comparisons of the presented algorithms. Finally, we conclude in Section 5 and outline open research issues.

2 Literature Review

A crucial factor for the improvement of the network lifetime and stability of sensor nodes is energy conservation in WSNs. Component cluster formation and Cluster Head (CH) selection is required for the proper sustenance of Quality of Service (QoS). A routing protocol based on an energy-proficient clustering is an important parameter for this. An Upgraded Bkd-Tree-Inspired Energy-efficient Clustering-based Routing Protocol (IBkd-Tree-IEFCRP) has been proposed as a conceivable method for the formation and management of the cluster [1]. The heterogeneous cognitive radio-based WSNs are then split into regions, with distance as the defining parameter, with specific singular spectra allocated to them.

Next, the distance calculation is used for dynamic clustering, and multi-hop communication is exploited for the routing of data [2] The nodes are eventually set in exacting environments for prolonged periods of time. These surroundings are not communicated to the nodes [3]. These nodes are subject to security invasions; the conciliation nodes guide the packets of data to the final station of the network.

In [4], a Fuzzy-based Secured Authentication and Clustering (FSAC) Algorithm is introduced, that monitors the transmitted packets of data, thereby avoiding such attacks. The existing methods do not take into account the significance of the distance factor while selecting the Cluster Head (CH) that ultimately resulted in the inefficient consumption of energy within the network.

In the study presented in [5], a method for CH selection based on the Distance-based Enhance Threshold Sensitive Stable Election Protocol (DETSSEP) is introduced, that utilizes factors such as the HMAC network energy, distance between base station and node, and the energy remaining in nodes.

A major factor that causes early death in nodes and reduction in network lifetime is the unbalanced consumption of energy in the wireless network. The reason for this is that the nodes near the sink handle more data traffic in comparison to distant nodes. To rectify this, a novel method was presented in [6], where a residual energy-based distributed clustering and routing (REDCR) protocol was suggested in this work. This method permits the multi-hop communication supported cuckoo-search algorithm and low-energy adaptive-clustering–hierarchy (LEACH) protocol.

Improvement in network reliability and longevity are critical parameters that have been concentrated on in this field. Routing mechanisms based on Swarm Intelligence, similar to the Artificial-Bee Colony (ABC) optimization and Tabu-Genetic Algorithm (TABU-GA) have been used extensively in [7] for optimization. These methods are much more advanced and preferred than other techniques.

In order to diversify the sensor modules to acknowledge a prolonged period of the wireless sensor network, the group-head must be reallocated or rotated once in a while. The work presented in [8,9] proposes a method to extend the WSN lifetime with smart nodes. A replacement algorithm has been suggested to reallocate the cluster head and suppress unnecessary data transmissions. This allows control over the cluster head rotation and the energy consumed by the sensor nodes. The model proposed in [10] amalgamates the replacement algorithm with a reduction in unwanted data transmissions. This allows control over the cluster-head rotation and the energy consumed at the sensor nodes. Maximum network energy and life of nodes are achieved with an energy-saving clustering scheme based on artificial and fractional artificial bee colony algorithms by selecting the most ideal cluster head in [11,12]. However, the intricate details of the model make improvements in the model necessary. The proposal in [13] illustrates a weighing model in the form of a price function to depict the selection of optimal cluster head problems. Furthermore, the artificial bee colony algorithm is improved with the help of a novel adaptive concept, the dynamic scout bee.

Large amounts of redundant information are also created when a multitude of sensor nodes begin to track targets. This ultimately leads to a reduction in system performance. The principle behind connectivity and cover HMAC optimization models is to achieve maximum direct node connectivity with the least number of sensor nodes, especially during the failure of sensor nodes. However, existing methodologies have not succeeded in selecting minimal nodes, as sown in [14,15].

An optimized algorithm and protocols in WSN are required for correct communication for sports programs. Error-free and consistent message processes are required between the hub and other nodes. Time-Division Multiple Access (TDMA) is a conceivable solution that is more reliable and allows node synchronization. The work presented in [16] stresses the possibility of TDMA and Polling TDMA being utilized for communication.

Battery-powered sensor nodes are vital in the design and construction of energy-proficient WSNs. Hotspots may occur near the node sink, and the clustering protocols in place may affect the energy consumed at each node. Another problem that may arise is the incorrect selection of nodes with insufficient energy, as cluster heads leading them to be loaded with heavy traffic when compared to their cluster members is shown in [17]. The selection of the most proficient cluster head by some automated mechanism or model still remains a difficult challenge in the case of network mobility. Computation of the load taken by each node in a network is one of the proposed solutions to this issue. In this paper, an energy-proficient and safe biased algorithm for clustering (ES-WCA) has been proposed for mobile wireless sensor networks based on a combination of 5 factors. One of the areas where these networks have been put into use is Cooperative Multi-Robotic Systems (CMRS) where

WSNs have to be dominant and vigorous in their action. These systems can also be employed in sensing functionality in areas that are not covered by the inert sensor by equipping the robots with specialized sensors that identify AoI and revert information to remote locations for further processing. However, these nodes have limited energy and energy-saving models that are proficient in packet routing, management of mobility, and cluster formation has great importance.

Another paper [18] introduces a non-uniform clustering routing protocol that is also energy-efficient, to improve the energy efficiency of nodes by maintaining the energy consumed in WSNs. Moreover, a non-uniform clustering network partition has also been introduced in order to decrease the possibility of the occurrence of energy holes. An enhanced shuffled frog leaping algorithm has also been introduced, that optimizes the dynamic selection of cluster heads. The study shown in [19] introduces a model named High-Quality Clustering Algorithm (HQCA) for the generation of high-quality clusters. This method uses certain criteria for determining the quality of the cluster, thereby enhancing the intra- and inter-cluster distances, decreasing error rates during the process simultaneously. Fuzzy logic and several other parameters are used for the selection of the optimal cluster head (CH). A novel algorithm presented in [20] called the Mobility-Aware Fuzzy Clustering Algorithm (MAFCA) has been proposed specifically for mobile WSNs. This model has been used to select cluster heads while maintaining the energy consumption as low as possible. This algorithm takes the mobility of the WSN into consideration while electing cluster-heads.

From the presented literature review, we deduced the following objectives that should be embedded to the proposed algorithm.

1. Decide the impact of energy devouring constituents and their predominant boundaries by large energy utilization in WSNs.
2. Obtain a quantitative estimation and display of the general energy utilization dependent on the predominant boundaries.
3. Force: Biosensors have a little scope of assets to give energy (e.g., an ordinary soluble battery utilized in such sensors just creates around 50 who of energy); the lifetime of a biosensor is regularly short of one month.
4. Computation: Due to the absence of memory, the biosensors can’t execute enormous digit calculations, so the energy consumption has to be calculated.
5. Security and obstruction: The biosensor network should be adequately secure to stay away from unlawful elements detailing bogus information to the control hub, or giving some unacceptable guidelines to the next biosensors and perhaps creating critical mischief to the host.
6. Material imperatives: The size, shape, and materials of the biosensor should be protected and compatible with the body tissue.
7. Mobility: The WSN of biosensors should uphold portability through the improvement of multi-bounce, multi-modular, and specially appointed sensor networks to give area mindfulness.

3 Proposed Methodology

As we have considered all the aforementioned factors, there is a nonlinear connection between the general energy utilization of the framework and its constituents relying upon the application and the general plan. Almost, this nonlinear definition requires more broad investigation, as there is no profound comprehension of measurements related to the energy of every constituent.

Additionally, there are no strong numerical models that can deal with a particular non-straight relationship. In this manner, a less difficult straight methodology is embraced, to show the general energy utilization and investigate the ramifications; future work will investigate non-linear methodologies.

In the accompanying recipe, the general energy is communicated as a straight blend of the IEPA's constituents. Exchange between the segments can be considered regarding their loads, as some capacity of the plan of the WSN and the application.

3.1 Statistical Analysis

We considered the energy model from [21]. Energy is used when dealing with information in the WSN through three cycles, to be specific: information transmission, gathering, and collection—the energy burned-through is, individually, meant as information transmission energy T_{xe}, gathering energy R_{xe}, and total energy T_t.

In contrast to an energy efficient data aggregation (EEDA), which stays fixed over the long haul, the estimations of T_{xe} and R_{xe} fluctuate, contingent upon the circumstance. In particular, T_{xe} relies upon distance d from the sending sensor hub to the recipient, and different definitions are utilized, relying upon whether d is above or underneath limit distance d_0. In the event that $d < d_0$, the free-space model is utilized, and the multipath model is utilized.

$$E_{Tx} = \begin{Bmatrix} l \times E_{elec} + l \times \epsilon_{fs} \times d^2, if\ d < do \\ (l \times E_{elec} + l \times \epsilon_{mp} \times d^4, otherwise \end{Bmatrix} \tag{1}$$

$$E_{Rx} = l \times E_{elec} \tag{2}$$

The total energy consumption of node i in the interval Δt based on a constituent of the IEPA can be formulated. Thus, the energy consumption will be determined in Δt as follows:

$$ECresidual,\ t2 = ECresidual,\ t1 - ECconsumed,\ \Delta t \tag{3}$$

$$ECconsumed,\ \Delta t = (\partial ECresidual,\ t/\partial t)\ \Delta t \tag{4}$$

$$\Delta t = t2 - t1 \tag{5}$$

$$Econsume, \Delta t = \lambda 1, \Delta t + \lambda 2 Elocal, i\ \Delta t + \lambda 3 Eglobal, i\ \Delta t + \lambda 4 Ebattery, i\ \Delta t + \lambda 5 Esink, i\ \Delta t \tag{6}$$

subject to:

1. $Eloca, \Delta t > 0\ (3-2)$
2. $Egloba, \Delta t > 0$
3. $\lambda 1 Eindiviual, \Delta t + \lambda 2, \Delta t + \lambda 3 Eglobal, i\ \Delta t + \lambda 5 Esink, i\ \Delta t < \lambda 4 Ebattery, i\ \Delta t$

3.2 Hybrid Media Access Control (HMAC) Algorithm

The data link layer is made up of two sublayers, one of which is the Medium Access Control (MAC) layer. The MAC layer's primary function is to transport data from a network's network-interface card to a common channel. The MAC layer, together with data link control, is in charge of the data link layer's complete physical addressing.

The aggregation information is delivered to a single sink node via communication in the WSN from numerous data sources. MAC protocols have come a long way with the advancement of technology, long before we used the additive links on-line Hawaii area (ALOHA) protocols, then slotted ALOHA, and so on. Then came the carrier, sensing multiple access protocols.

In our study, we use an HMAC [15], which is a TDMA-based mechanism built specifically for star topology. To govern active and sleep times in a WSN, there is a Bayesian statistical model for MAC, which is a contention-based MAC protocol. With a burst time of 10 ms, the hub was designed to send 2000 requests to each node. There was no time gap between the hub and the node in the test. If the hub communicates with only one node, it will send 200 samples per second; however, if it communicates with four nodes, each node will send 50 samples per second. As a result, the sample time difference will be 40 ms.

3.3 Polling Time-Division Multiple Access (PTDMA) Algorithm

Dynamic wireless Adhoc networks (Dynamic WANs) are self-organizing, autonomous systems, in which computing devices require networking applications when a fixed network infrastructure is unavailable or undesirable. In these situations, computing devices may create an Adhoc network, which is a temporary network set up to meet the communication needs of the moment. Wireless technologies are the foundation of Adhoc networks.

Our design choices are based on basic radio technology, with the goal of serving applications with strict timing constraints. TDMA frames are considered having a fixed number of fixed-length timeslots. The use of TDMA frames with a fixed-length radio time is ideal for applications that require a lot of delays.

The goals of the Polling TDMA routing protocol are to make it scalable as the number of nodes grows, to respond to any topology dynamic, to provide free routes, to minimize delay, to be centralized, to provide numerous routes, and to be power efficient. The model is a control acknowledgment format in which the hub and mobile nodes share a single communication channel in the Polling TDMA, as shown in [16].

3.4 Improved Energy-Proficient Algorithm (IEPA)

In this investigation, we recommend a better energy-proficient algorithm (IEPA) to HMAC out the period of the WSN built IoT. The suggested IEPA comprises some successive parts. Initially, an ideal number of clusters is resolved for covering the adjusted clusters. At that point, the fair stationary clusters are shaped based on an altered fluffy C-implies calculation by joining this calculation with a system to decrease and adjust the vitality use of the sensor hubs. Ultimately, cluster heads (CHs) are chosen in ideal areas with the pivot of the cluster heads works between individuals from the group, dependent on another cluster heads‘ determination revolution calculation by incorporating a back-off clock system for cluster heads determination and pivot instrument for cluster heads turn. Table 1 shows the IEPA algorithm.

Table 1: Improved energy-proficient algorithm (IEPA)

Algorithm
Step1: Appointing the level and the hand-off degree to hubs in the graph Subsequent to interfacing every hub to its area and developing organization graph $G = (V, \mathrm{E})$, a hub is allotted a level and a hand-off degree. Beginning from the sink hub (marked “0”)

(Continued)

Table 1: Continued

Algorithm
Step2: Characterizing and assessing the association cost between hubs
$E = N_r * A_d * N_n * S_n * N_h$
Energy = Radius between nodes * Average distance * number of neighbors * Size of the network * number of hop count
Step3: Dijskstra-based most reduced cost.
mC = min (mC, Source Dist[u] + c/2 + dest dist[v]) where,c current edge cost, Source Distance is cost of path from node 1 to u source dist[v] is cost of path from node v to N
Step 4: End;

Furthermore, Fig. 2 depicts the various steps involved in the IEPA Algorithm. Specifically, the proposed convention diminishes and poises the energy utilization of hubs by refining the grouping structure, where the IEPA is reasonable for systems that want a long lifetime.

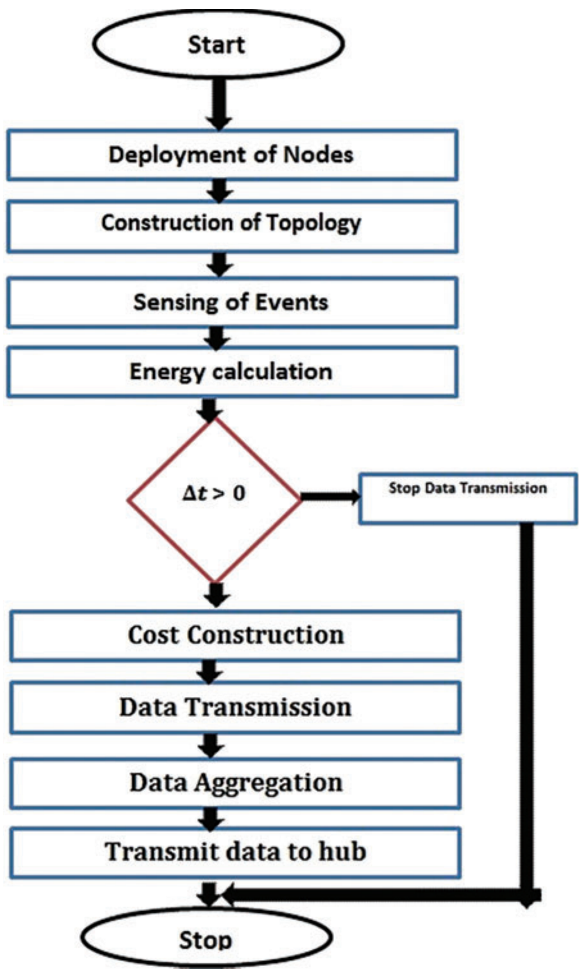

Figure 2: Steps involved in the improved energy-proficient algorithm (IEPA) protocol

4 Results

4.1 Simulation Parameters

Table 2 depicts the values of the simulation parameters, in which the number of nodes taken for simulation is 200, and the topology size ranges from 200 to 1200 m. The three protocols, HMAC, PTDMA and IEPA are compared with a queue length of 30, and also with 40. The packet size considered is 500 to 2500.

Table 2: Simulation parameters

Parameters	Value
Channel	Wireless
Number of nodes	10–200
Topology size	100 m ∗ 100 m–120 m ∗ 120 m
Protocol type	HMAC, PTDMA & IEPA
Transmitting node range	20 m
Initial Energy	1000 J
Bandwidth	2M bit
Queue length	30 & 40
Simulation time	50 s
Traffic type	CBR[1]
Packet rate	250 kb
Packet size	500–2500

Note: [1]CBR stands for Constant Bit Rate.

4.2 Simulation Analysis

The IEPA Algorithm was demonstrated in the well-known organization test system NS2 with the simulation parameters shown in Table 2, which utilized different organization situations. The boundary portrayal is given underneath, and the recreation comprises versatile hubs and a sink with geography going from 20 m, and utilized the convention of Ad hoc On-Demand Distance Vector (AODV) upgraded with the IEPA ideas. The communicating hub range was 1 m, and the underlying energy of hubs for the re-enactment was 1000 Joules. A traffic rate of Constant Bit Rate (CBR) was utilized. The bundle size of 500 to 2500 was utilized, and different re-enactment tests were made. The line length going from 10 to 50 was considered for re-enactment with various situations, and the yield was recorded.

Table 3 shows the comparison of events and energy consumption. It is noticed that IEPA monitors an additional drive than HMAC and PTDMA, with the increment in information rate, detecting unwavering quality, and occasion age time, and the quantity of hubs separately.

Fig. 3 depicts the examination of normal energy utilization of our projected IEPA convention, with the PTDMA and HMAC conventions for changing information rate, detecting unwavering quality, occasion age time, and the quantity of hubs separately.

Table 3: Comparison of events and energy consumption

HMAC		PTDMA		IEPA	
Events	Energy consumption	Events	Energy consumption	Events	Energy consumption
0.70	0.087	0.66	0.078	0.67	0.059
3.3	0.076	3.32	0.068	3.31	0.046
6.0	0.061	6.0	0.054	6.01	0.039
10.0	0.056	9.9	0.047	9.9	0.034

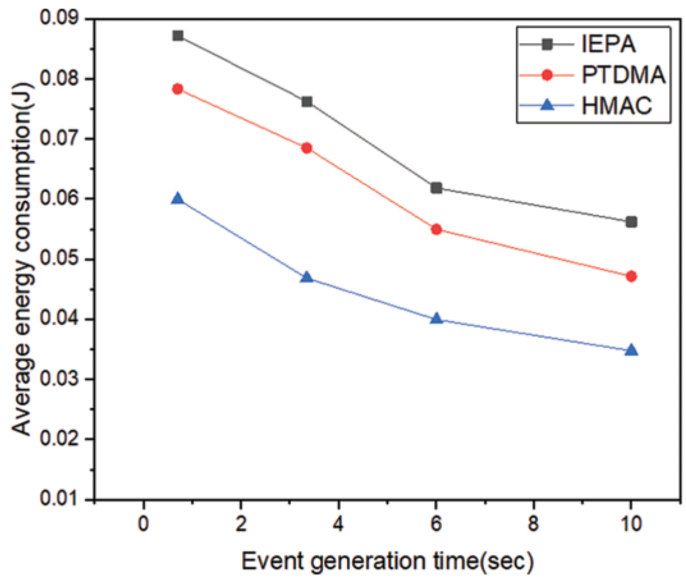

Figure 3: Energy consumption (j) *vs.* Event generation time (sec.)

Fig. 4 shows the detecting unwavering quality of the sub-regions expanded from a lesser range to a higher range separately. We established that the energy utilization stays steady for existing mechanisms. The energy utilization of IEPA increments relatively as for detecting dependability. Table 4. With the increment in detecting dependability, the information transmission hub, for example, the source hubs increases.

Fig. 5 depicts that the parcel decreases speed increments with the increment in information rate relatively. Almost, the proposed IEPA convention performs better compared to the current conventions because of the decreased number of home hubs than the existing protocols, as shown in Table 5.

Fig. 6 shows the slip proportion of the IEPA, HMAC, and PTDMA conventions for the expansion in occasion age Time. The movement loads diminish with the expansion in occasion age time, prompting the decline in parcel miss proportion. Besides, the traffic capacity in the IEPA is least when contrasted with the further construction-free information total conventions. Along these lines, the miss proportion of our IEPA convention is not as much as HMAC and PTDMA.

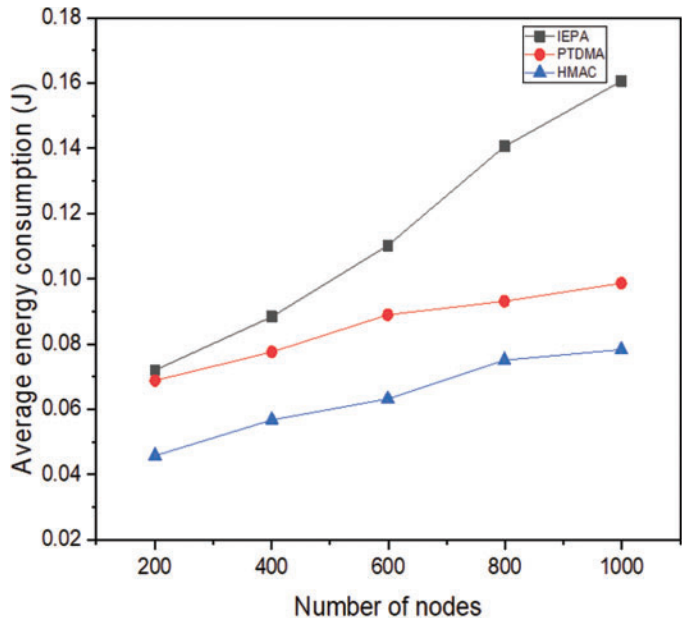

Figure 4: Energy consumption (J) *vs.* Number of nodes

Table 4: Comparison of nodes and energy consumption

HMAC		PTDMA		IEPA	
Nodes	Energy consumption (J)	Nodes	Energy consumption (J)	Nodes	Energy consumption (J)
200	0.07	201	0.07	201	0.05
401	0.09	401	0.08	400	0.06
599	0.11	599	0.09	600	0.06
799	0.14	800	0.09	802	0.08
999	0.16	1000	0.10	1000	0.08

Fig. 7 shows the missing proportion concerning the quantity of hubs. There might be countless sensor hubs in a district because of the thick arrangement of sensors in a WSN to detect the occasions which happened in that particular area. In this way, an occasion might be detected and communicated by various sensors, from which the source is the previous information accumulation procedure rather than information conglomeration close to the sink, and it lessens the traffic essentially. Subsequently, the IEPA beats in the great thickness, due to the approach basis accumulation though the second mechanism, which accomplishes a close to bowl total by choosing an essential aggregator close to the sink.

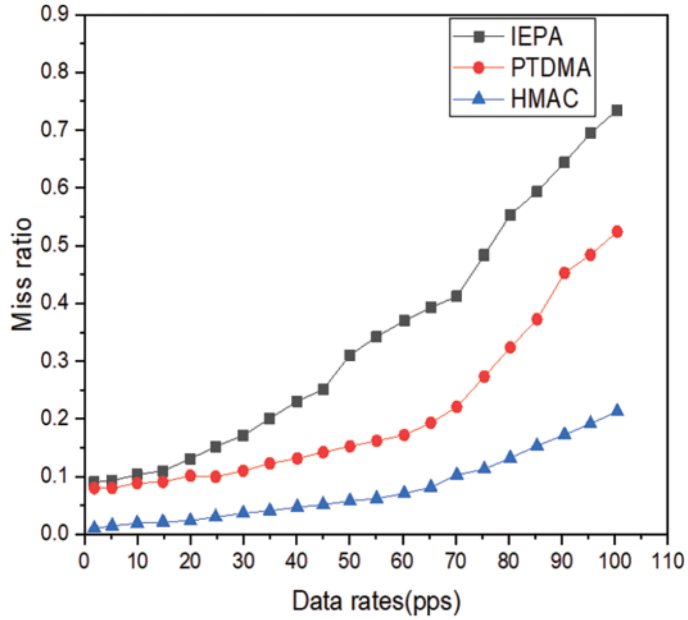

Figure 5: Miss ratio *vs.* Data rates (Pps)

Table 5: Comparison of delay with event generation

HMAC		PTDMA		IEPA	
End to end delay (s)	Event generation (s)	End to end delay (s)	Event generation (s)	End to end delay (s)	Event generation (s)
3.01	0.35	3.00	0.34	3.02	0.32
5.00	0.33	4.98	0.31	4.98	0.28
7.03	0.31	7.04	0.27	6.98	0.22
10.02	0.29	9.98	0.25	9.99	0.13

Fig. 8 shows the start to finish delay for increment in the information rate, occasion age time, and the quantity of hubs individually. Our holding-up approach changes the holding-up time bound in the hub progressively, based on the cut-off time of the parcel.

Fig. 9 depicts the end-to-end delay of PTDMA, HMAC, and IEPA increments with the increment in the information rate. In HMAC, because of expansion in the information rate, the end-to-end delay increments gradually. It is simply because of the increment due to blockage. Be that as it may, the start to finish postponement of PTDMA is such that it achieves results between HMAC and IEPA.

The IEPA increments relatively with an expansion in the information rate because of the clog, holding-up time, and misfortune recuperation. Our projected convention has fewer movement loads than the existing mechanisms, as a result of the chosen sum of contributors. Hence, the exhibition of the projected IEPA is superior to the current conventions regarding the start to finish delay.

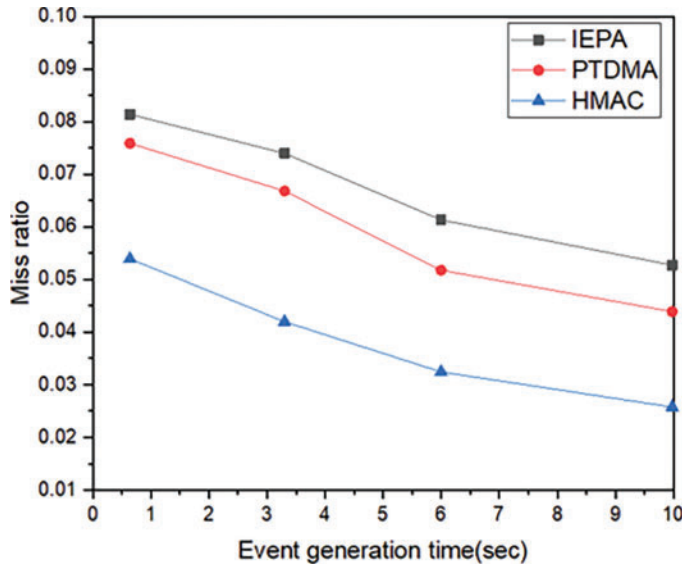

Figure 6: Miss ratio *vs.* Event generation time

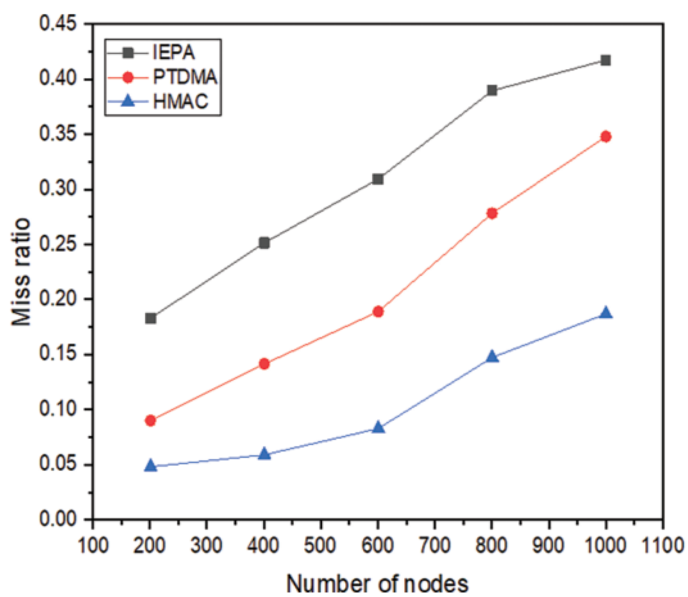

Figure 7: Miss ratio *vs.* Number of nodes

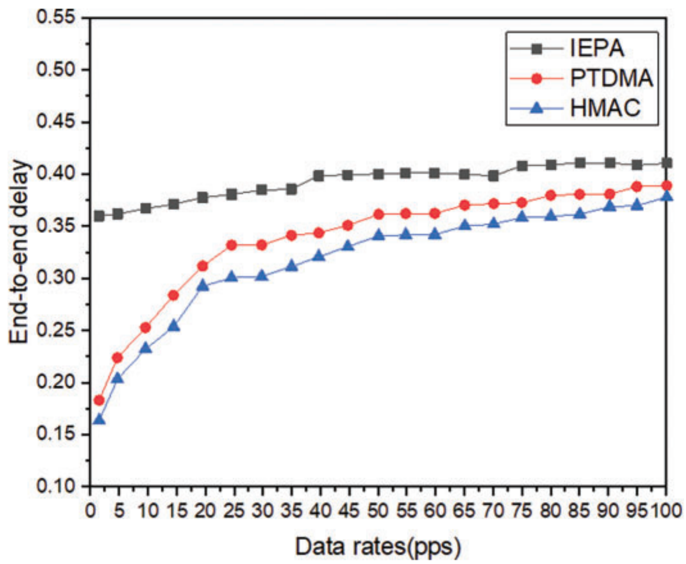

Figure 8: End-to-end delay *vs.* Data rates

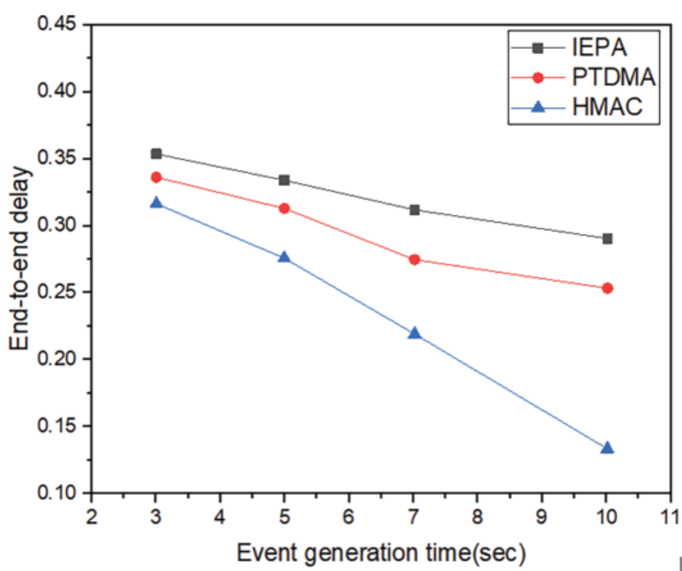

Figure 9: End-to-end delay *vs.* Event generation time (Sec.)

5 Conclusion

In this paper, a new methodology for limiting the absolute energy utilization of remote sensor network applications was introduced, dependent on the Hierarchy Energy Driven Architecture. Specifically, we distinguished parts of every constituent of the IEPA. A model was extricated for every one of the constituents from a sensor-driven perspective; a sensor hub inside a WSN burns through its effort on three constituents: the individual constituent (the presence of the actual sensor), the neighborhood constituent (the sensor as an individual from its nearby local area), and the worldwide constituent (as an individual from the sensor organization). At that point, a definition for the complete energy cost work was proposed regarding their constituents. Reproduction results for lifetime and lingering energy of an example network with various sensor sweeps, transmission range, and irregular and specific directing strategies exhibited that our model and definition can be utilized to advance energy utilization by and large, and decide the commitment of every constituent and their relative importance. Further work will involve the design of an application for coaches using the secured efficient algorithm, along with the reduction of energy of the sensor nodes.

Funding Statement: There is no funding for this work as this is an original work by the authors.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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