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Energy Efficient Sleep Awake Aware (Eesaa) Intelligent Sensor Network Routing Protocol

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***Abstract*—If the diversification of sensor hubs is not ap- propriately utilized, the power consumption within the system might be unregulated and the load distribution may be uneven which will affect the performance of the system in some ways. Steering algorithms need to focus on energy conservation and load balancing among many different types of nodes in order to increase the network lifetime. One way to do this is to make use of cooperative in cluster routing such as the SEED algorithm to reduce unnecessary transmissions and save energy. Unfortunately, this method suffers from dead time effects which leads to wastage of energy across the network. Further, SEED has limited capacity when the sensor node is active.**

Heterogeneous traffic rates. To address the energy and traffic diversity problem of the sensor networks, the Traffic and Energy Aware Routing TEAR relative algorithm had been proposed and explained in detail. That is, TEAR will not choose an active node that is low on power but high on the traffic rate to be the group leader for the sake of load balancing. However, TEAR does not prevent neighboring sensor networks from duplicate transmissions. In this work, we propose a hybrid Energy and Traffic Aware Sleep Wake (ETASA) strategy to enhance the energy efficiency and load balancing in heterogeneous wireless sensor networks.

***Index Terms*—Energy saving, traffic congestion, network con- nection, communication, sleep, wireless sensor network.**

I. INTRODUCTION

There have been numerous developments in the field of various Management Information Systems however, the most Preferred has been the Improvement of Technologies. Ad- vancements in such technology enabled the collection and passing of important as well as useful information to relevant recipients. In this category of WSN applications, the focus is on smart buildings: A system of sensors and information technologies automatically and remotely monitor the energy consumption in the building, track the parameters of the indoor environment as well as the utilization of its space. WSN is constituted of numerous scattered, passive, ultra small, low power wireless sensor nodes deployed in the region of interest, like outlying areas or incident locations to collect relevant data. Microminiaturized sensor nodes, which can sense an event, process the information and transmit it have raised lots of questions in research. There are distributed algorithms to handle and monitor self-configurable wireless sensor networks where trigger events are widely spread and dynamically al- tered. Such compact and battery powered sensor nodes work on limited computational and storage capabilities. Because of this configuration, WSNs being mobile and subjected to dynamic environments may face such node disconnections that will affect the performance of WSNs negatively. For proper functioning, it is essential to come up with the design of communication

systems and protocols which are low in energy consumption and thus prolonging the lifespan of the network. Centralized algorithms are spoiled in a case when a major node

becomes inactive and that leads to considerable loss of warranties on the protocol which cannot be used in fresh deployments. On the other hand, decentralised protocols deal with such failures more effectively.

II. DESIGN

”Energy and Traffic-Aware Cluster-Based Routing Protocol for Wireless Sensor Networks” is designed to optimize energy efficiency and data transmission in wireless sensor networks by exploiting the unique characteristics of heterogeneous sensor nodes. The protocol starts by randomly distributing sensor nodes in an area $K \times K$ in recognition of the difficulties of manual deployment in large-scale or hostile environments.

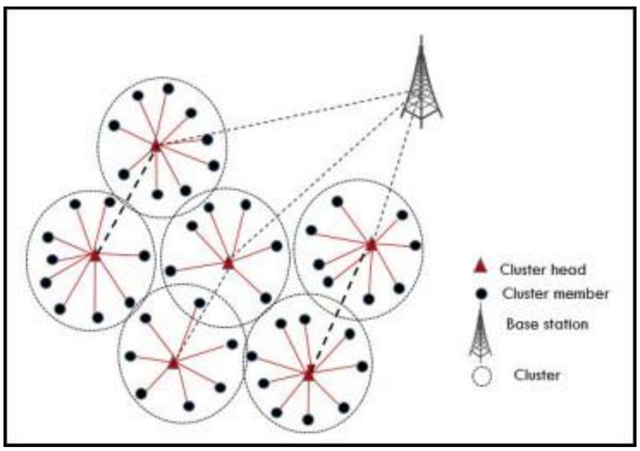


Fig. 1. clustring Process

Each node has a different initial energy level and traffic rate, which affects the network performance.
To facilitate communication, nodes are organized into clus- ters using designated cluster heads (CHs) selected based on weighted probabilities considering energy and traffic condi- tions. The protocol includes a modified TDMA scheme for data transmission, where time slots are allocated based on the number of nodes and traffic patterns, allowing paired nodes to alternate between data exploration and transmission, thus reducing energy waste. The key feature of the protocol is an energy-efficient and traffic-aware wake-up mechanism. Each node continuously monitors its energy level and traffic rate, switching between sleep and wake-up states based on predefined thresholds. When the node’s energy drops below a certain level, it switches to sleep mode if its traffic rate is not higher than that of its

neighbors, providing effective load balancing.

Datasets are generated on the CH where data from cluster members are collected and transmitted to the base station, min- imizing transmission overhead. The simulation setup involves deploying 100 sensor nodes in a 100m area with a central base station. By evaluating various performance indicators including energy efficiency, data delivery ratio, latency, and load balancing, the protocol performance can be comprehen- sively analyzed compared to existing methods. Ultimately, this approach aims to optimize data transmission while improving the resilience and efficiency of WSNs to extend the network lifetime.

A.FORMATION OF PAIRS

This section elaborates on the scaling of sensor nodes spatially within the network to achieve efficient load distri- bution and energy conservation. Unlike earlier instances of matching nodes in similar traffic distribution networks, type of traffic distribution is utilized in our case. Sensor nodes that reside in the same area and which belong to the same application are matched up since they are likely to collect the same measurements and transmit this to the base station.

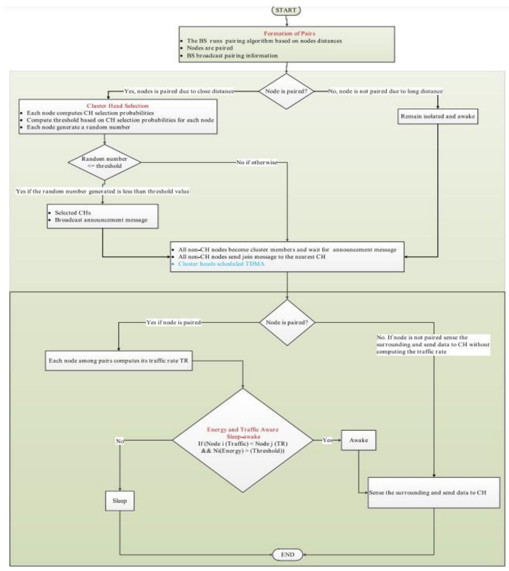


Fig. 2. System flowchart

This helps eliminate excessive transmission so as to avert the occurrence of conflicts which can compromise the efficiency of the network. The nodes that were paired alternately perform activities like data sensing and transmission whereby one node is active while the other node is in a power saving mode. The management of the pairing/ grouping process is done from a central location that has all the nodes provisioned with their location and where they transmit their location and id to the base station. The base station determines which nodes are within close range and suggests pairing for those that are all less than 10 meters apart and have the same function. This information on the pairing is subsequently sent to the entire networked nodes with the result that non-adjacent nodes are not grouped.

B. CLUSTER HEAD SELECTION

In this approach, the Cluster Head (CH) is responsible for cluster management, data transmission scheduling, data col- lection and aggregation, and acts as a communication channel between cluster members (CMs) and base stations (BSs). CH selection is probability-based, where a node becomes a CH if its randomly generated number is less than a certain threshold. This threshold is determined by factors such as node energy, traffic load, and the number of pairs. In order to prolong the network lifetime, the selection process does not select nodes with high traffic, low energy, or fewer pairs, because these nodes consume more energy. Instead, nodes with high energy, low traffic, and more pairs are more likely to be selected. The

Fig. 3. Traffic and energy sleep-awake rotation

CH selection formula ensures that these factors are balanced, and nodes change roles over time. The average amount of energy consumed per round and the optimal number of clusters are also taken into account in the selection process to improve the efficiency and load balancing of the entire network[8]

C. *CLUSTER HEAD TDMA SCHEDULE*

In this approach, the cluster head (CH) allocates a time slot to each sensor node to avoid data collisions and to save energy by putting the node into a sleep mode when it is not transmitting data. Traditional TDMA systems assume that each node always has data to transmit, which is not always the case. In such systems, nodes must remain active during their assigned time slots even if they have no data to transmit, which wastes energy. The CH is also idle during this period, which further increases the energy loss.[7]
In traditional systems, each node in the group receives its own time slot, even though only one pair of nodes transmits data at a time. This leads to unnecessary time slots being used, especially for paired nodes. The total number of time slots in a cluster is determined by the number of paired groups (Pg), the number of nodes in each group (Ng), and the number of isolated nodes (Un).
For example, if there are 4 paired groups of 5 nodes each and 5 isolated nodes, the total number of time slots is:

$$Nslots = ((4 \times 5)5) - 1 = 24$$

If each time interval is 10 seconds, the total time for all intervals will be 240 seconds. Our approach helps to reduce the number of time slots by grouping paired nodes together and assigning only one time slot per group, which helps to save time and energy.

D. *ENERGY AND TRAFFIC AWARE SLEEP-AWAKE AP- PROACH*

The ETASA approach extends the network lifetime by using an energy and traffic-aware wake-up system. Paired sensor nodes alternately stay awake or asleep depending on their energy level and the amount of data being transmitted. In the first round, the nodes rotate evenly, but in subsequent rounds, each node counts the number of messages it has sent compared to its paired nodes. Nodes that process more data (more traffic) consume more energy, while nodes with less data consume less energy. For example, a node with less traffic consumes less power than a node with more traffic (e.g., node E with less traffic, node A with more traffic). This system helps distribute the workload by using nodes with less traffic more frequently, and conserves energy on nodes with higher traffic.
The process works as follows: Each node calculates the average traffic rate and compares it with the other nodes in the pair. If the traffic rate of the currently active node is low and has enough energy, it stays active to retrieve and

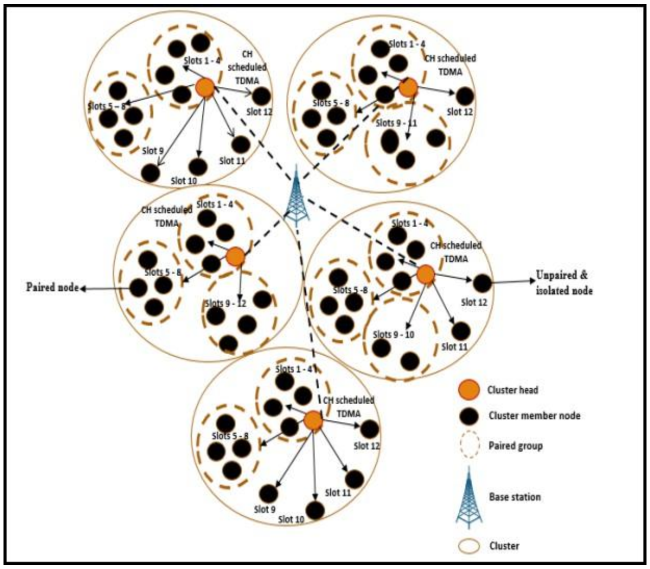


Fig. 4. Paired groups and isolated nodes

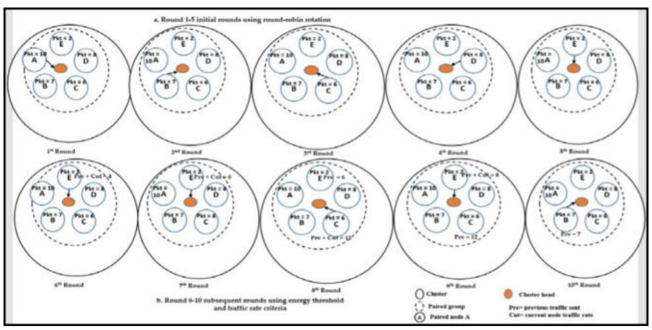


Fig. 5. Traffic and energy sleep-awake rotation

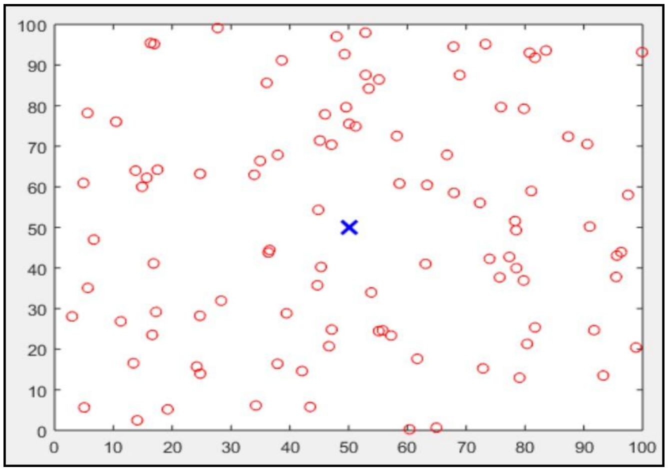
transmit data. If the traffic rate is higher, [6] it goes into sleep mode, allowing the other node in the pair to wake up and handle data transmission. This method of alternating sleep and wake reduces unnecessary energy consumption and balances the workload based on traffic and energy. Also, if the traffic rates of two nodes are similar, the node with more energy is chosen to remain active. The system also estimates the total energy consumption per round to ensure that the node has enough energy to remain active in the network.

III. SIMULATION SETTINGS

In our simulation setup, we deployed 100 sensor nodes in a 100m x 100m area for periodic monitoring, with a receiver node (base station) in the center. We implemented this approach using MATLAB for simulation. The network simulation parameters used correspond to those specified in previous studies [1]

The table below shows the traffic rates and power consump- tion of five sensor nodes.

1) Node A: Traffic rate 10 kbps, initial energy 0.5 J.



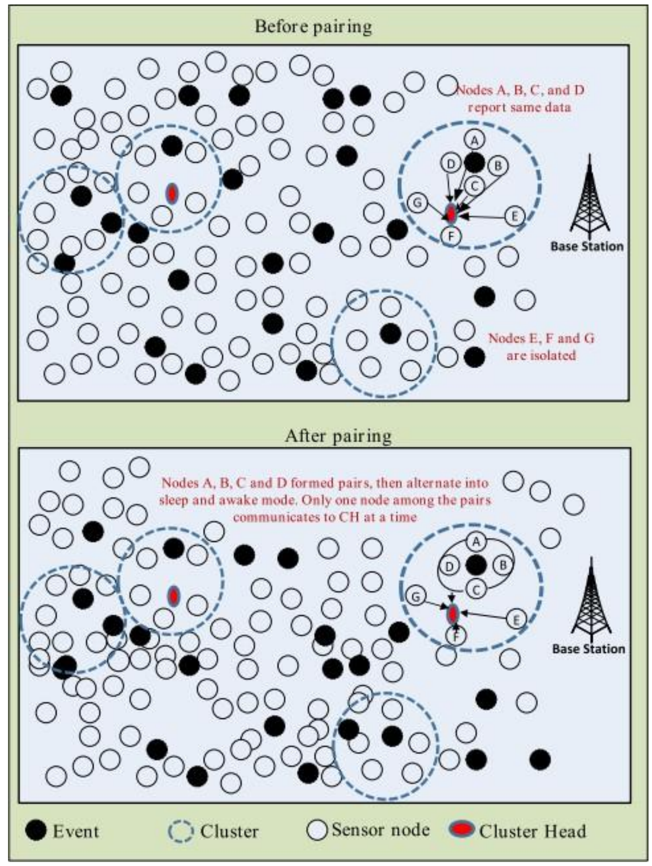


Fig. 6. Paired and isolated nodes data transmission

2) Node B: Traffic rate 7 kbps, initial energy 0.7 J, con- suming 0.2 J to send data to CH.
3) Node C: Traffic rate 6kbps, initial energy 0.6J, consumes 0.15J to send data to CH.
4) Node D: Traffic rate 8kbps, initial energy 0.8J, consumes 0.3J to send data to CH.
5) Node E: Traffic rate 2kbps, initial energy 0.5J, consumes 0.02J to send data to CH.

These settings help to evaluate the performance of the proposed approach considering energy and traffic.

A.NETWORK MODEL

This section describes the assumptions and details of the network model for wireless sensor networks (WSNs). To monitor the environment, N sensor nodes are randomly placed in $K \times K$ areas. In large or complex environments, it is difficult to manually distribute nodes, so we use random distribution, and nodes are static once they are configured. The algorithm that controls when nodes go into sleep or power-saving mode checks the energy level of each node. If a node is active and not acting as a cluster head (CH), it goes into power-saving mode. When in sleep mode,[5] it wakes up and sends data. While awake, the node estimates the traffic rate of its neighbors and broadcasts its state before going back to sleep mode under certain conditions. The algorithm also compares the energy of

Fig. 7. Simulation environment.

each node with a threshold. If the node has low energy but has a higher traffic rate than its neighbors, it goes to sleep, while nodes with sufficient energy and low traffic rate stay awake. Through this process, every node transmits data at least once and adjusts its state according to its energy and traffic rate. Each node has different energy levels and traffic rates. That is, nodes with high traffic transmit larger packets and more messages, consuming more energy.

B. PERFORMANCE EVALUATION

In this segment. Execution of the proposed approach (ETASA) We look at the presentation of bunching calculation SEED [2] because of the utilization of a conventional matching and-wake approach and TEAR that for the most part thinks about traffic heterogeneity. Utilized SEED convention Cyclic mode interface way to deal with limit overt repetitiveness Transmission from sensor hubs in nearness To accomplish energy effectiveness. The downside of SEED is The listening personal time issue because of the utilization of regular TDMA booking Between CMs. Basic listening brings superfluous Energy utilization. Also, SEED convention can't adapt to this. The climate has heterogeneous traffic sensor hubs. Then again, TEAR tackles the traffic heterogeneity issue by not choosing hubs with weighty traffic as CH jobs to accomplish load adjusting. Nonetheless, TEAR convention can't keep away from copy transmissions from sensor hubs in closeness. What's more, TEAR doesn't give fundamental energy saving components to limit energy utilization of hubs with weighty traffic. Thusly, the proposed ETASA convention is assessed and contrasted and SEED and TEAR utilizing the accompa- nying assessment measurements.

C. NETWORK LIFETIME

Network lifetime The network lifetime is the time that an organization spends sending messages directly from the hubs. The network becomes impractical. This can be seen in: Different perspectives depending on the domain of use. For example, it can be thought of as a round of communication

Node	**Traffic rate (kb)**	**Initial energy (J)**	**Energy consumed to send data to CH (J)**
Node A	10	1	0.5
Node B	7	0.7	0.2
Node C	6	0.6	0.15
Node D	8	0.8	0.3
Node E	2	0.5	0.02

Fig. 8. Traffic rate and energy consumption

until it passes through the main hub, or as a round until it passes through a specific hub. It is a concentrator level, and can be further considered as: It repeats until all the energy stored in the last concentrator is exhausted. Organization. In this study, we consider the network lifetime. From three alternative perspectives. We considered the network lifetime immediately when the main hub switches, as in [3]. Also, the service lifetime when half of the hubs

have passed is (half of the concentrators have dropped their hooves). Ultimately, we were also considered as an organization. Lifetime when the last hub of the organization is lost All your energy. Conditions (28)
- (32) are numerical conditions used to generate important in- formation about: Lifetime of our proposed ETASA agreement. Submission 12244 Vol. 8, 2020 N. M. Shagari et al.: ETASA Swarm-Based Heterogeneous Guidance Agreement for WSNs In SEED study, for ETASA implementation TEAR calculation is presented in terms of the service life of the organization. In Figure 5. Fundamental Dispatch (FND): This is the time it takes to detect this. Also, the communication is coordinated until the first hub in the organization exhausts all its energy.

D. Conclusion

In this paper, we explore the energy performance and load regulation issues in heterogeneous WSN contexts. Heteroge- neous Even if the sensor hubs are not properly utilized, the energy usage may be uneven and the overall load distribution may be unbalanced. Organization that deteriorates the image of the organization. Control computation should aim at achiev- ing energy performance. In addition, load balancing among heterogeneous hubs extends the life of the organization. One solution is Using periodic duty fulfillment in group manage- ment. Saving Energy Dissipation Rest (SEED) computation Limits excessive transmission to achieve energy efficiency. However, this scheme will limit repetitive tasks. In the trans- mission process, he faces the problem of inactive listening. It causes energy waste in the entire organization. Also SEED cannot adapt to the following climates: Sensor hubs with non-uniform data transmission rates. Adapt The energy and traffic heterogeneity issues between sensor hubs, A consensus has been proposed A direction that takes traffic and energy into account is called TEAR. TEAR does not select low-energy concentrators, It performs load balancing for high traffic rates,

Parameter	Value
Number of sensor nodes (N)	100
WSN Area (K x K)	100m x 100m
Initial energy lower bound (E_0)	0.5J
Energy consumed in *Tx/Rx* electronics (E_{elec})	50nJ/bit
Tx Amplifier energy dissipation in free space scenario (E_{fs})	10pJ/bit/m^2
Tx Amplifier energy dissipation in Multipath scenario (ϵ_{mp})	0.0013pJ/bit/m^4
Energy consume in Data Aggregation (E_{DA})	5nJ/bit/signal
Packet length lower bound (M_0)	4000bits
Idle power consumption	19.5mW

Fig. 9. Simulation parameters

such as group work, But TEAR does not Prevent repetitive transmissions from sensor hubs located In close proximity. To address these issues, we proposed A transition to Macintosh- level quality with mutual accountability, A network layer to address the issues of inactive configuration and repetitive configuration, A transmission that performs energy efficiency and load balancing. In this paper, we propose a crossover technique called Component. Energy and Traffic in Conscious Rest (ETASA) It further improves energy efficiency and load balancing in heterogeneous WSN situations. Unlike previous strategies, In ETASA, matching hubs alternate between resting and alerting modes. It considers the energy and traffic rate of the hubs. Furthermore, We modify the general TDMA scheduling for SEED. We distribute one discovery for each matching collection in the group, So that instead of SEED, we assign discovery to all individuals. A consistent group (not all hubs have information to report). A group leader. It is designed to solve the inactive listening problem to limit energy usage. The proposed technique Includes a good group leader selection process. It further improves the adjusted energy usage by selecting hubs with high energy usage, low traffic, and high matching. The proposed approach is evaluated and analyzed against TEAR and SEED in terms of lifetime, residual energy, and throughput. The results show that the proposed ETASA provides 16Set up different areas in similar organizations.

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