# LOAD AND ENERGY AWARE CLUSTERING PROTOCOL FOR IOT WIRELESS SENSOR NETWORKS

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***ABSTRACT:*** *In the Internet of things (IoT) based on Wireless sensor networks (IoT-WSN), conservation of the network resources can be done by arranging the devices into clusters. In the cluster head (CH) assortment procedure, several factors are measured bearing in mind the necessities of IoT-WSNs. In this paper, a load and energy-aware clustering protocol for Iot-WSN is proposed. The network is organized into clusters. In each cluster, a combined cost function is derived for each node based on the load, distance, and remaining energy parameters. Then the nodes are classified as suitable, not suitable and unfit for becoming the CH, depending on the cost function. The CH selection algorithm then selects the suitable nodes as the CHs in each round. The gateway or relay nodes are also placed in cluster borders in order to connect the adjacent clusters.*

## 1. INTRODUCTION

IoT is a developing field of research that incorporates a plethora of areas of study. The main idea of IoT is to connect all things like home appliances, smartphones, cars, buildings, robots, machines, etc. to the Internet. The idea is to have a virtual counterpart for all devices in the physical world that sense information of interest from the surroundings so that advanced end-user services can be provided. One of the main concerns while using such devices is energy efficiency as communication and computations at the constrained device might quickly exhaust its limited battery resources [1]. IoT offers instantaneous admittance to evidence associated to any device with high efficiency and competence [2]. IoT trusts on the interrelated substances that can communicate with one another and gather data of their background. The devices are presumed to be armed with the network boundaries of low-power short-range wireless protocols such as Zigbee, in order that transmission amongst themselves are probable.

Maintenance of the network sources may be probable by combining the IoT devices into clusters [3]. One of the application systems to enhance dynamic ingestion is clustering. Clustering methods are chiefly attentive to the communication portion of the WSNs by extending the lifespan. In the CH assortment procedure, several factors are deliberated bearing in mind the necessities and situations of WSNs. In this procedure, each node cannot be appropriate to adopt the part of CH because of low dynamism, insignificant place, and expanse from BS, etc [4].

The clustering mechanism arranges the devices into groups and chooses CHs, and subsequently transfers the collected data from the CHs to the BS node through communication substructure systems. On the other hand, the CHs ingest more energy as related to other devices in the systems as they are more concerned and disperse extra energy to transfer accumulated data to the BS[5].

In this paper, a load and energy-aware clustering protocol for Iot-WSN is proposed.

## 2. Related Works

Shesha Sreenivasa Murthy et al [6] have discovered grouping as a method to advance dynamic efficacy for a range of present and developing IoT usage situations. They familiarized a new load-balanced grouping procedure centered on replicated strengthening whose key objective is to upsurge system period while preserving ample detecting reportage in situations where sensor nodules create even or uneven data congestion. To this finale, they also familiarised a novel grouping rate function that accounts not only for sensor nodule congestion load but also for the rate of communicating over corporeal expanses. By widespread replications associating the suggested procedure to principal hi-tech grouping methods, they presented that their procedure can progress both system period as well as system coverage by keeping additional sensor nodes active for lengthier phases of the period at a lesser computational charge.

Zhihui Wang et al [7] have suggested an enhanced spin mechanism of group head centered on LEACH. The chief notion is to curtail the renovation of the group and alter the group head in a unique group. They approved symbols here. The replication investigation a lout comes on the NS-2 stage display that the development can interrupt the demise time of the initial node, which creates the energy ingestion of the entire network more average. The suggested enhanced mechanism is effectual.

Yifeng Zhao et al [8] have suggested a dispersed active group-head assortment and grouping system centered on an enhanced K-means procedure and constructed a scheme replication stage to feign and examine the suggested procedure. The replication outcomes display that the suggested procedure can suggestively progress the efficacy of the scheme. Now, they have mostly deliberated the influence of the LTE-M cellular system.

Jaime Zornoza et al [9] have familiarised a novel adaptive mixture grouping method for mesh cooperative networks. The suggested active diffusion plan tries to competently aid on-site data delivery bearing in mind the site inconsistency of smart mobile devices comparative to organized immobile sensor nodules, with a specific application use circumstance: threat situations.

Jilong Li et al [10] have suggested a grouping centered routing procedure bearing in mind an intrusion and load harmonizing routing metric that emphasizes diminishing the prevailing problems of networks. In this research, they suggested a system that lessens the endwise suspension but also offers complete concern to both the excellence on the complete track to the terminus and to the estimated lifespan of nodes with blockages from piled congestion in IoT. Concurrently, it uses mesh location station intrusion and line info suitably to discourse the recognized encounters.

## 3. Load and Energy-Aware Clustering (LEAC) Protocol

### 3.1 Overview

In this article, a load and energy-aware clustering protocol for IoT-WSN is proposed. In this protocol, the system is split into groups. In each cluster, a combined cost function is derived for each node based on the load, distance, and remaining energy parameters. Then the nodes are classified as suitable, not suitable, and unfit for becoming the CH. The CH selection algorithm then selects the suitable nodes as the CHs in each round. The gateway or relay nodes are also placed in cluster borders in order to connect the adjacent clusters.

### 3.2 Cluster formation

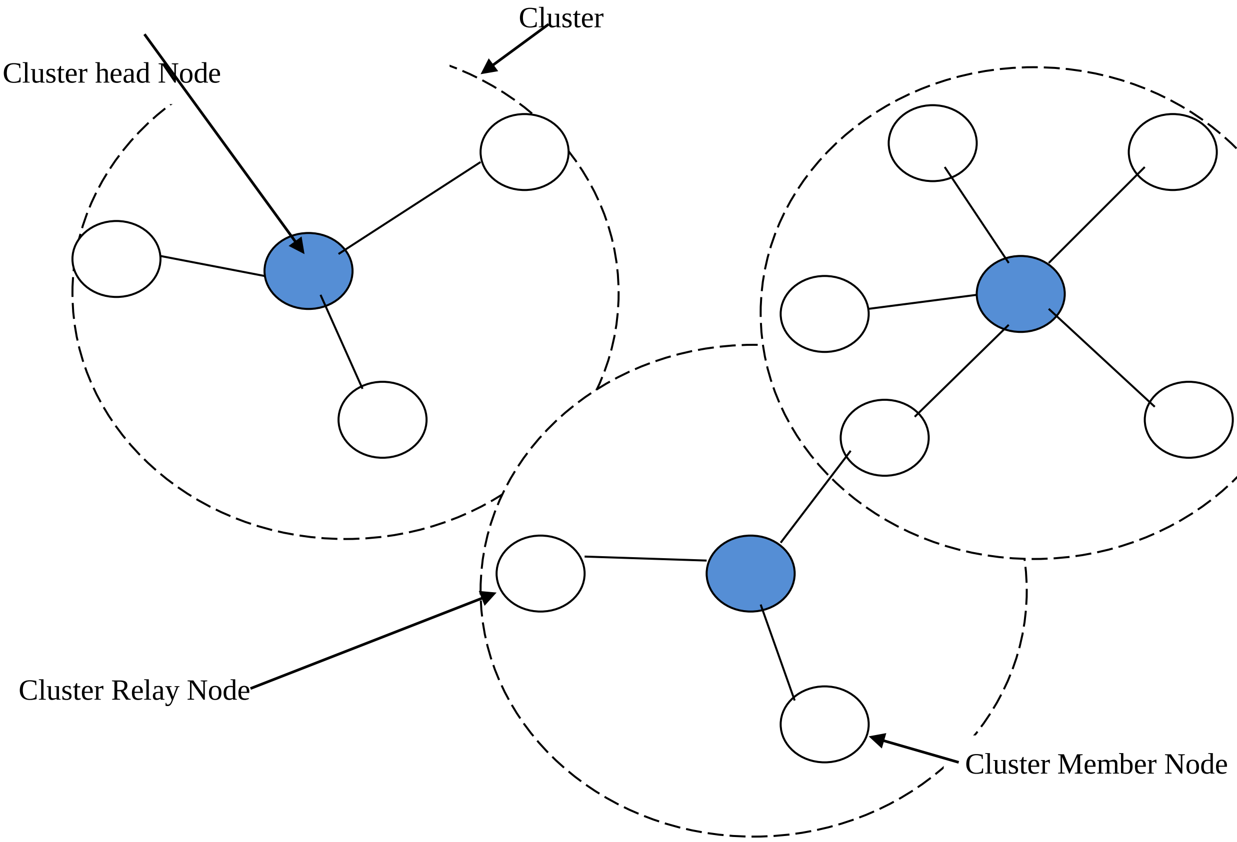


**Figure 1 Clustering Structure of Network.**

This paper considers a scenario of multi-hop data transmission in an IoT-WSN, in which the entire nodes are arbitrarily organized at determinate expanses with the BS. The system is split into dynamic clusters such that each cluster is having unequal size. Every cluster can be recognizable by an exclusive ID as Cluster ID.

Cluster formation is an effectual method to lessen the routing charge of a WSN. A cluster establishment procedure is used to establish the system into clusters. A cluster comprises a cluster head (CH), cluster member (CM) nodules, and despatch nodes. In the cluster formation phase, the entire nodes transmit their info to their adjacent. The evidence specifies the position of the node that aids to construct the adjacent list.

a) CH: It is responsible for maintaining cluster members. It is nominated from the details of adjacent node evidence.

b) CM: It is a member of a cluster.

c) Cluster Relay Node (CR): An arbitrating node that links the space amid two adjacent clusters and is in the straight revelation of these clusters.

### 3.3 Estimation of the cost function

In order to select a CH, a cost function is derived from the following metrics

- Distance between the sensor node and CH ($D_{i,\,CH}$)
- Distance between CH and BS ($D_{CH,\,BS}$)
- CH's current load ($L_{CH}$)
- CH's remaining energy ($ER_{CH}$)

The remaining energy of each node (ER) after a data broadcast is assessed by means of Eq (1)

$$ER = E_i - (E_{tx} + E_{rx}) \qquad (1)$$

where is the preliminary energy

$E_{tx}$ is the diffusing energy

$E_{rx}$ is getting energy

Then the cost function is computed as

$$Cost_{CH} = \frac{ER_{CH}}{(\sum_{i=}^{m} D_{i,CH}) * (D_{CH,BS}) + L_{CH}} \qquad (2)$$

Generally, $D_{CH,BS} > D_{i,CH}$

### 3.4 Classification of Nodes

The network having N nodes can be divided into three sets as N = *{S, NS, UF}*. Where, S denotes the set of nodes which are suitable to become CH, while NS denotes the set of nodes that are not appropriate for becoming CH in the current time interval. UF is the set of nodes that are considered unfit for becoming CH.

There are three levels of threshold values for $Cost_{CH}$: $U_{th}$, which is the upper-level threshold, $M_{th}$ which is the medium level threshold, and $L_{th}$ which is the lower-level threshold.

Here $U_{th} > M_{th} > L_{th}$

Primarily, the nodes and the BS plan a marginal to discriminate the entire S and NS nodes while taking the entire probable factors and policies of the nodes.

The classifications are assigned as shown in Table-1.

**Table 1. Considerations for cluster head (CH) selection.**

| Value of $Cost_{CH}$ | Condition for $Cost_{CH}$ | Type of node |
|---|---|---|
| High | ($>=U_{th}$) | S |
| Medium | Between $M_{th}$ and $U_{th}$ | S |
| Low | Between $L_{th}$ and $M_{th}$ | NS |
| Very Low | Less than $L_{th}$ | UF |

### 3.5 CH Selection Algorithm

The following algorithm illustrates the process of CH selection:

***Algorithm:CH Selection***

```
round = 1
While (round<round_max)
 For each ClusterID in N
     For each node N_i in ClusterID
     Estimate Cost_CH
     If Cost_CH= High or Medium Then
     add N_i to S
     Else if Cost_CH= Low Then
     add N_i to NS
     Else if Cost_CH= Very Low Then
      add N_i to UF
      End if
     End For
      If S ≠NULL, then
      Select N_j∈S as CH
     End if
      round = round + 1
```

Algorithm 1 provides the optimal solution for selecting the CH by checking all its possible parameters. Furthermore, in Procedure 1 every group is deliberated and then the entire nodules inside that group are categorized for the groups S, NS, and UF. The final outcome of this Procedure 1 allows us to regulate the appropriateness of nodules for being CHs.

## 4. SIMULATION RESULTS

### 4.1 Simulation settings

The proposed Load and Energy-Aware Clustering (LEAC) Protocol for IoT Networks is implemented in NS2 and compared with the Simulated Annealing clustering (SAC) approach [6].

In simulation experiments, 20 to 120 nodes are placed within a boundary of 50m X 50m. The load is increased in terms of data sending rate from 50 to 250Kb. The MAC protocol used is IEEE 802.15.4. Initial energy assigned to all nodes is 10 joules, the transmission and reception powers are fixed as 0.8 and 0.5 watts, respectively.

### 4.2 Effect of increasing the nodes

In simulation experiments, the number of nodes is increased from 20 to 120.

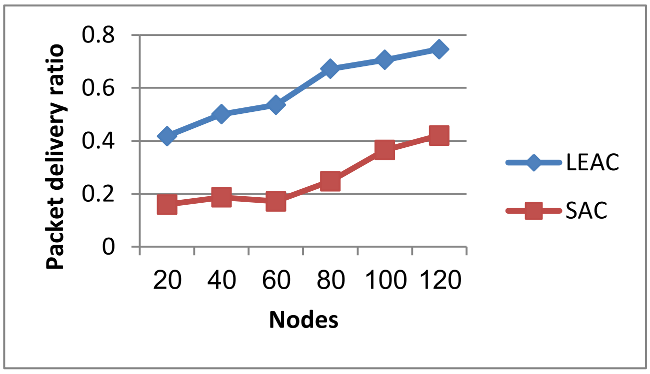


**Figure 2 Packet delivery ratio of nodes**

Figure 2 shows the packet delivery ratio of both the protocols. From the figure, it can be seen that the packet delivery ratio of LEAC is 57% higher than SAC

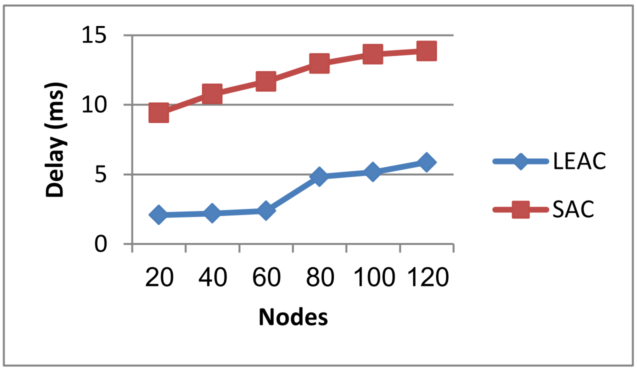


**Figure 3: Delay of nodes**

Figure 3 shows the delay of both the protocols. It can be observed that the delay of LEAC is 72% lesser than SAC.

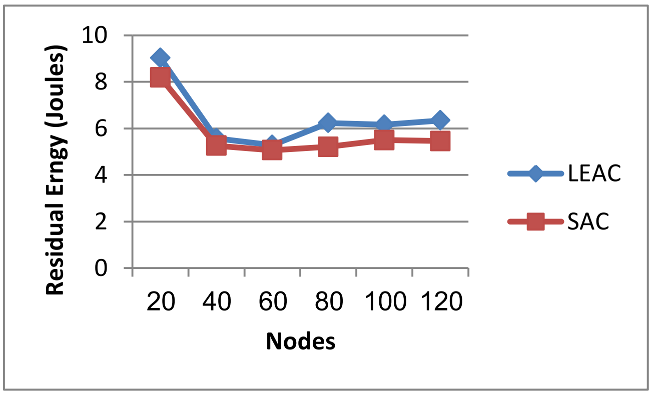


**Figure 4 Residual Energy of nodes**

Figure 4 shows the residual energy of both protocols. It can be seen that the residual energy of LEAC is 10% more than SAC.

### 4.3 Effect of increasing the data sending Rate

In simulation experiments, the data sending rate is increased from 50 to 250Kb.

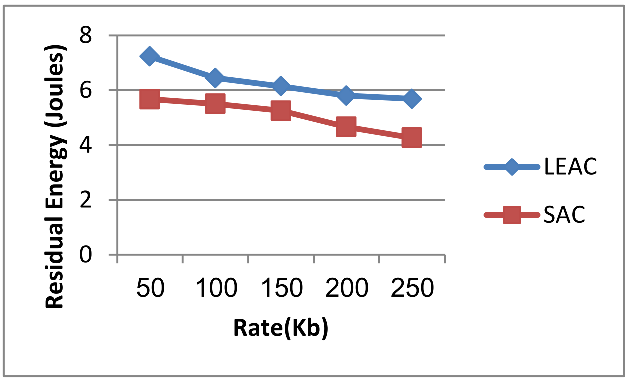


**Figure 5 Delivery Ratio of Rate**

Figure 5 shows the packet delivery ratio of both the protocols. From the figure, it can be seen that the packet delivery ratio of LEAC is 70% higher than SAC

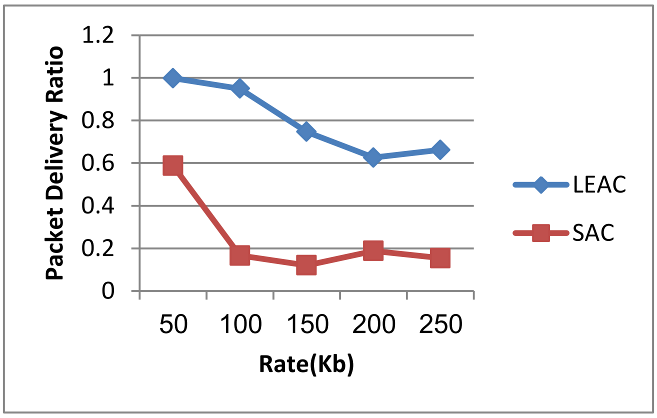


**Figure 6: Delay for Rate**

Figure 6 shows the delay of both the protocols. It can be observed that the delay of LEAC is 70% lesser than SAC.

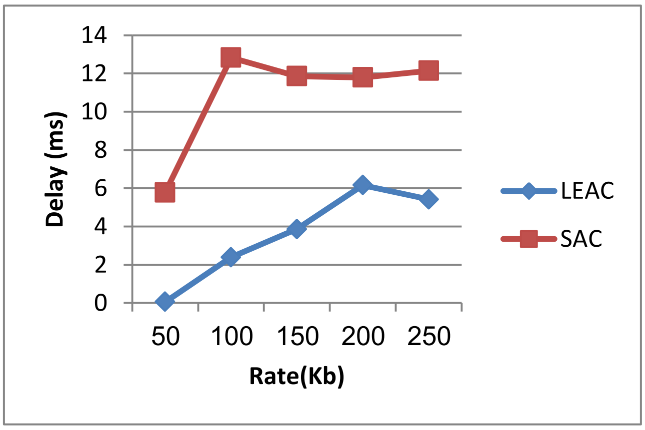


**Figure 7 Residual energy for Rate**

Figure 7 shows the residual energy of both protocols. It can be seen that the residual energy of LEAC is 19% more than SAC.

## 5. CONCLUSION

In this paper, a load and energy-aware clustering (LEAC) protocol for Iot-WSN is proposed. In each cluster, a combined cost function is derived for each node based on the load, distance, and remaining energy parameters. Then the nodes are classified as suitable, not suitable, and unfit for becoming the CH. The CH selection algorithm then selects the suitable nodes as the cluster heads in each round. The gateway or relay nodes are also placed in cluster borders in order to connect the adjacent clusters. By simulation results, it has been shown that LEAC protocol has attained high residual energy and packet delivery ratio, compared with the existing clustering approach.

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