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COLLABRATIVE LOCATION BASED SLEEP SCHEDULING WITH LOAD BALANCING IN SENSOR-CLOUD

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Abstract: **The mobile cloud computing (MCC) with wireless sensor networks (WSNs) is an emerging Technology gets attraction because they combine the data gathering ability of sensor nodes with the computational capacity of the cloud. This MCC-WSN technology improves the WSN performance level. For instance sensor, networks are lagging with its storage capacity and processing ability this can be overcome while implementing sensor with the cloud. The WSN-MCC is linked by the gateways, which is placed on both side i.e one is at sensor side and another one at cloud side. Compression takes place at sensor's gateway and decompression in the cloud. The cloud not only store sensory data from nodes but it also simultaneously transfers information to a mobile user who sends the access data request. The most of the integrated sensor-cloud schemes fail to observe the following criteria: 1) mobile user location 2) One of the predominant issues in WSN is power consumption since most of them are equipped with non-rechargeable batteries 3) Load balancing with efficient coverage and connectivity. This paper focuses on above observations and introduces the novel approaches known as Load Balancing With Collaborative Location sleep scheduling with load balancing (LCLSS) Scheme. Both awake and asleep status of each sensor node dynamically devised by schedulers and the scheduling is done purely based on the of mobile users current location. Mostly the sensors are deployed in remote areas there replacing the battery is quite difficult, so it is necessary to reduce the power consumption. This can be achieved by using Proper Scheduling and Load balancing mechanism.**

Keywords: **Sleep Scheduling, Mobile cloud computing, wireless sensor network, integration, location, Discrete Point of Interest.**

I. INTRODUCTION

1.1 *Wireless Sensor Networks (WSNs):*

The WSN contains numerous amounts of sensor nodes that can be implementing using deterministic or in a random manner. A Communication between the two sensor nodes can be done using multi-hopping, i.e., the intermediate node present between the source node and the destination node is act as a relay. The base station is also known as a sink. In fig 1.1 shows the methodology of communication operation process takes place in the wireless sensor network. The sensors nodes are placed in the sensor field from their data are collected and then collected data are routed towards the sink. The sink also known as a base station, they act as a Centralized medium for data aggregation and routing.

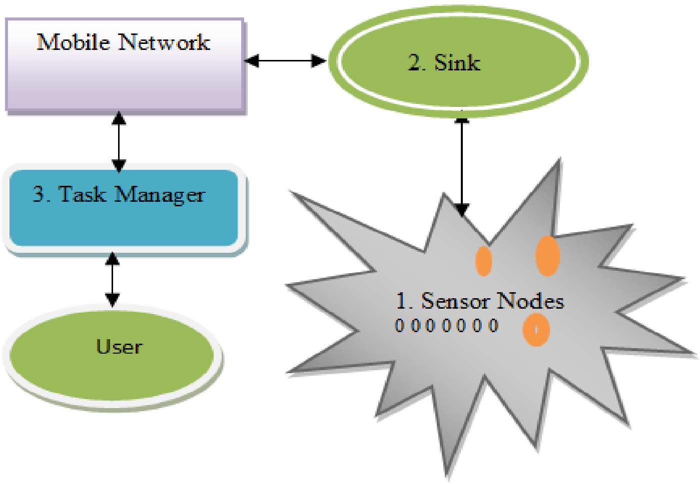

Fig 1: WSN Node Communication

The base station connects the real world with the virtual world. The Task manager controls all the functions takes place in the network such as storing the data, processing and displaying.

1.2 Cloud computing:

Cloud Computing can be explained as the computing process can be delivered through the Internet. Both software and hardware can be managed and maintained by the trusted third party at some other remote place. For instant Google Drive, DropBox, Gmail, Facebook and online application form. The user can access their stored information and resource from anywhere and this can be possible one if the user is available with internet connection.

1.3 Integration of WSN and MCC:

The integration of sensor-cloud is a budding platform that merges the sensing ability of sensor with high computational and high storing capacity of the cloud. This Integration Process retrieving several shortfalls of sensors for instant storage and processing capacity and these can be made obvious by a cloud technology. Since cloud provides a huge data storage and computational capacity, it won't be a difficult task to gathers huge amount of data from the different sensor nodes. The cloud and sensor network are connected together by two gateways as schematic as shown in figure 1.2.From which one is placed at WSN side and another one is at Cloud. The sensed and stored data at cloud are transferred regularly to the cloud only if any mobile user sent a request message to the Cloud.

1.4: Scheduling and Load Balancing:

One of the predominant issues in WSN is power consumption since most of them are equipped with non-rechargeable batteries and Most of the sensors are deployed at hazardous and remote areas. Both wake up and sleep status of each sensor node are dynamically devised by schedulers and the scheduling is done purely based on the of mobile users current location; in this manner large amount of energy, wastage is minimized at WSN. The load balancing technique is also crucial because they equally distribute and routing the data through minimum traffic area. It underwent coverage and connectivity problem. In order to preserve the Quality of Service (QOS), the sensor networks should try to achieve the target coverage without losing the Connectivity between the sensors. They construct the dynamic cover tree by divide sensor field into a number of the parent and child node. It makes only a few nodes to be maintaining at active state from this the specific coverage without losing any connectivity, higher lifetime, reducing delay and increasing throughput can be achieved.

II. LITERATURE SURVEY

In general, scheduling is defined as the proper planning of things that take places within a specific time. The proper scheduling will not only reduce the power consumption and it also helps to maintain the load in the network. Power management is indispensable because mostly they are powered by a battery. Sleep scheduling follows an idea to reduce the power usage by implementing the scheme of sleep and active state. The sensor is maintaining in the awakening stage for a particular instant of time (e.g. detection) and its goes to sleep state at rest of time. The power consumption is occurring, even at sleeping state, but they are very low when comparatively with other stages (i.e., an idle state, waiting for stage and transition stage). An Adaptive Partitioning Scheme for Sleep Scheduling and Topology Control is discussed in [11].It characterizes that patterned node are scheduled with the topology control using connectivity-based approach (CPA).The network connectivity can be preserved by the CPA algorithm; by doing this the energy consumption and improving the quality of sensor network are achieved. The node partitioning is purely based on connectivity, not on their location. In connectivity-based approach, a merging process is a crucial function because the completely adjacent nodes of two groups are combined together through this function only.

In Energy-Efficient Wake-Up Scheduling is used for Data Collection and Aggregation [12], they used the Time Division Multiple Access (TDMA) protocols for scheduling sensor nodes. The scheduling is done in a single bundle, in this protocol, they maintain the sensor nodes utmost twice. The node is maintained in sleep state one for transmitting the data towards its child nodes and another one for receiving the from the child nodes. The new scheme for Sleep Scheduling is introduced at [13], A distributed activity scheduling algorithm with partial coverage. These protocols focus on coverage; they provide partial coverage instead of full coverage since full coverage is insignificant. The DASSA targets nodes which are placed near to the base station or sink because all the data are transmitted through these nodes which placed near to the sink only. The DASSA Schedules the node which is purely based on a residual energy and the number of neighboring nodes presents in the network. The DASSA schemes are used to enhancing the network lifetime.

MOBILE USERS:

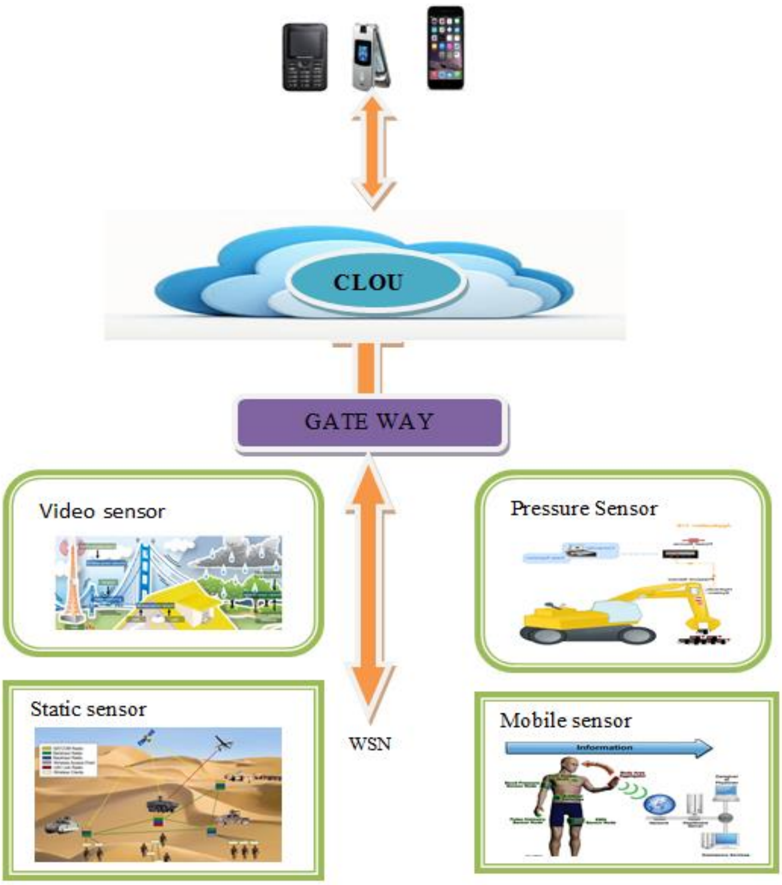

Fig 2: Integration of WSN-MCC

In Range-Based Sleep Scheduling (RBSS) for Wireless Sensor Networks approach[14], it describes that without using the location information they simply schedule the networks by using the distance between them.This RBSS is focused on the network coverage and it provides 100% coverage ratio when compared with others.They control the transmission collision but underwent a ranging error. In the paper Evolutionary Multi-objective Sleep-Scheduling Scheme for Coverage in Sensor Networks with the differentiated network. It describes that nodes controlling can be done based on sleep scheduling using online density based on event detection probabilistic. The node scheduling is done based on an optimization algorithm. The Decision maker is used for maintaining coverage and energy level at nodes. It also reschedules the nodes once a node failure occurs.

2.1 PROPERTIES OF SLEEP SCHEDULING SCHEME:

The desired properties are achieved from Sleep Scheduling:

1. Minimizing Power:

The basic function of sleep scheduling algorithms is to schedule the data flow when the node is at awakening state. A sleep scheduling algorithm is more efficient than others as it greatly reduces the power consumption.

2. Maximizing lifetime:

Most of the sensors are battery powered and they are deployed in a hazardous area where replacing of the battery is impossible. Under this circumstance, it is important to consume the low-level energy. This low-level energy consumption can be conventionally provided by sleep scheduling algorithm.

3. Reliability:

In order to increase the sensor networks reliability and maximizing the sensor lifetime, sensor networks can be implemented with wide range of sensor and it can be extended up to 20 nodes/m^3, under this dense deployment scenario, the possibility of the whole sensor may operate at the same duration leads to wastage of energy. Thus, the reliability of sensor network can be improved through sleep scheduling by maintaining the certain node in the awakening stage for certain time period.

From the survey, we studied various sleep scheduling algorithm in terms of energy consumption, network lifetime, and coverage. Sleep scheduling algorithm is used to balance sensor node's power consumption and a reasonable length towards energy saving while deploying WSNs for practical applications. The Storage capacity is still lagging in WSN. In order to overcome this, we presented the new approach known as Integration of WSN with Mobile Cloud Computing (MCC) as a result.

Table 1: Analysis of Sleep scheduling

Ref. no	Algorithm	Pros	Cons
[8]	Adaptive partitioning scheme	✓ Reduction of energy consumption	✓ Connectivity problem
[9]	Energy-Efficient wakeup Scheduling	✓ Minimizing the energy cost	✓ Increased delay
[10]	Distributed activity scheduling	✓ Desired coverage without using any location information ✓ Maximizing Network lifetime	✓ Gain is reduced, ✓ randomness increased
[11]	Evolutionary multi-objective Scheduling	✓ Optimized framework	✓ Rearrange the network, when the network is failed
[12]	Range based scheduling	✓ Reduction in number of working ✓ sensors and control messages ✓ 100% coverage area	✓ Effects of ranging errors

III. MCC-WSN INTEGRATION MODEL

Overall System Model:

Consider, N number of sensors (i.e. S_1 S_2 S_3 …S_{N-1}) were implemented at the field with multi-hopping at the sender's side along with multiple numbers of mobile users (i.e., M_1 M_2 M_3 ....$M_{N-1)}$ at the receiving side. The mobile users and WSN are connected by the cloud like a bridge. The cloud sends the stored information to the mobile user only if they send a data request to the cloud. The cloud gathered this information from WSN. Using global positioning system (GPS) a cloud gathers information about a mobile user's location which was provided at the handset. The gathered information are collected and stored in a cloud by using the Star-Track service which is running as one of the services provided by a cloud [15]. The two different gateways (or) base station are used in WSN-MCC, first one is placed at WSN and another one is placed in the cloud. Unlimited energy supply is provided at the base station and using the mobile user's location list. The nodes are scheduled based on the mobile user location. The locations of the mobile user are scheduled based on time (T) and it is divided into a number of time epochs with the regular interval (t).

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Overall WSN model:

The N-hop sensors are implemented neither uniformly nor randomly manner with N nodes in a two dimensions area A. The network area is designed by a graph(G).The hopping existing, when the two neighboring nodes are presented within the transmission range if $l_{(i1,I)} \sum L$ otherwise they will search for new one.

G= (I, L) ------------------> (3.1)

Where G=Graph

I= Set of Sensor Nodes

L=Set of Links ($L_{(1,2)}$ $L_{(2,3)}$ $L_{(3,4)}$ ….$L_{(N-1,N)}$)

WSN Energy Model:

The energy model is designed based on the energy utilization of a sensor to send and receive a data for one byte, then the calculation is made by using how much power has needed to amplify each transmitted and received byte to cover the distance of 1m. This includes the packet header and sensed data with body content. The energy consumed to transmit and receive a packet of length (h) bytes over distance (d).

Transmitted energy (E_T):

$E_T = e_t + e_a * h * d^2$ ------------------> (3.2)

Received energy (E_R):

$E_R = e_r * h$ -------------------> (3.3)

Where

e_a = energy consumption of power amplification

e_t = energy consumption of transmitting a byte

e_r= energy consumption of receiving a byte

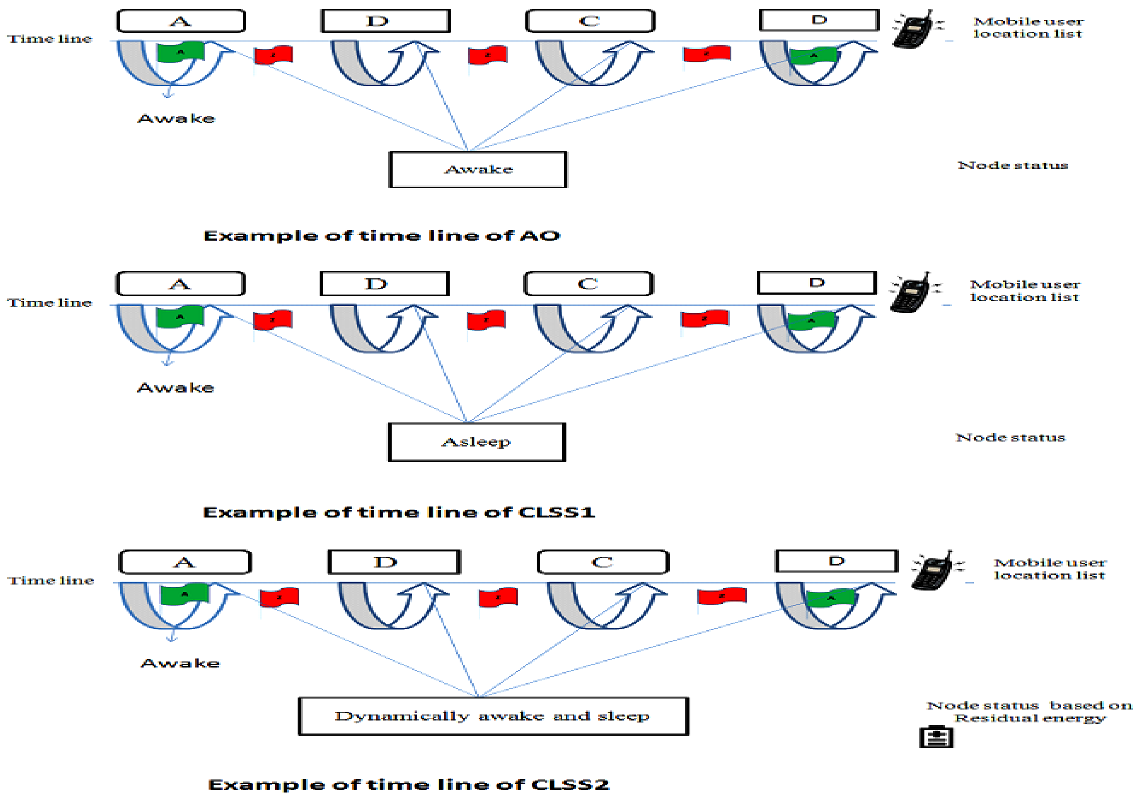


Fig 3: Schematic Representations

Pseudo code of CLSS Scheme

CLSS1

Step1: Current User Location List can be obtained by a cloud

Step2: If mobile user presents at the location list, flag A Sends to a base station/Always on(AO) nodes from a cloud

Step3: AO broadcasts flags to sensor nodes k

Step4: The node K, which receives a flag A maintains to be inactive status

Step5: If receives flag Z they goes to Sleep status

CLSS2

Step1: CLSS1 nodes go to sleep state automatically without underwent any condition in that case of CLSS2 nodes will enter into a sleep state by using residual energy (Eranki)

Step2: Before they enter into a sleep state, the sensor nodes broadcast their residual energy and receiving from neighbors

Step3: All nodes in the subset of currently awakening are connected by nodes with Erank > Eranki.

Step4: The node enters to the time epoch, at least, they have k neighbors from the subset of currently awakening node.

Pseudo code of CLSS Scheme with Load Balancing

Step1: Once node K receives flag A, before it getting start to routing their data packet

Step2: Searching for a node with minimum load. This can be done by checking the condition at step4-5

Step3: Check the Buffer Size and Residual Energy remaining at the sensor nodes

Step4: update the status of all the nodes

Step5: this information can be shared ,while they sharing HELLO MESSAGE between the nodes

Step6: After routing the size of buffer will be incremented by one

WSN Event Model:

Space and time are used in the event model with a characterizable distribution. When a sensor node receives a signal with power above a predetermined threshold level at that time only sensing is done at sensor nodes. For an instant, a Poisson and spatial distribution process from that a Poisson process takes place over the entire sensing region with an average event rate for the temporal event behavior and an independent probability distribution is used for events of the spatial distribution. Using GPS the mobile location list are captured periodically and it transferred to the cloud and it runs as one of a service on the cloud server.

IV. CLSS SCHEME

In this following section, the detailed description is shown how the location list of the mobile user is obtained, and then CLSS schemes are discussed and finally load about balancing at the sensor nodes (fig 2).

Mobile user location list:

The Mobile user location list can be getting from the user location history (L_H) which is gathered and stored in the cloud. The Star Track Service can be implemented in the cloud that can be used to collects the mobile user location list. Using GPS the mobile location list are captured periodically and it transferred to the cloud and it runs as one of a service on the cloud server.

$$P_{et} = \frac{\int Ao\ pxy\ (x,y)}{\int A\ pxy\ (x,y)} \text{------------------>}\ (3.4)$$

Where, A=Poisson process with an average event lambda

Pxy(x,y)=Independent Probability Distribution Function

Ao =Event detected by a sensor node

Finally, the processed locations data are broken down into various discrete tracks are operational and recoverable through a high-end application level of programming interface and they make up the location history list.

Mobile User Prediction Location List:

Transition Graph is utilized for making the prediction location list. The future locations of the mobile user could depend on the locations list of a user, where they can be visited frequently based on this key idea the list is summarized and also mobile user future track will be collected by these frequently visited locations. Finally, the Location lists L of the mobile users are combined form of a mobile user location history list and mobile user prediction location list.

Always On:

The AO nodes are always maintained to be active status even the mobile user is not at the mobile user location list. It acts a base station to transfer data between the sensor network and a cloud.

CLSS1:

From the cloud, a mobile user current location is gathered, based on the location history of the user.The cloud decides either a Flag A or Z is sent to the base station. If cloud sent flag z to the base station its goes to the sleeping state and broadcasting the flag Z to the sensor nodes and make them to an inactive state. Otherwise, they broadcast the flag A and maintaining the sensors nodes to be in wakening state.

CLSS2:

Both CLSS1 and CLSS2 scheme working principles are same, but the difference occurs when they receiving flag Z. The CLSS1 nodes go to sleep state automatically without underwent any condition in that case of CLSS2 nodes will enter into a sleep state by using residual energy (Eranki) and buffer size. The energy consumption based on connected K-neighborhood (EC-CKN) sleep scheduling scheme of the sensor nodes. Before they enter into a sleep state, the sensor nodes broadcast their residual energy and receiving from others. The node enters into the sleep state, if they satisfy the following condition:

1. All nodes in the subset of currently awakening are connected by nodes with Erank > Eranki.

2. The node enters to the time epoch, at least, they have k neighbors from the subset of currently awakening node.

Modeling the Load of Sensor Nodes:

The previous CLSS scheme [17] fails to concentrate on load balancing a load in a network. The load balancing is also critical in order to maximize lifetime, throughput and decreasing delay. The workload can be balanced and distributed equally to a sensor node in order to achieve a higher level of performance. The load is directly proportional to the sensed amount of data to be transferred through the network. The network congestions occur due to heavier load transmission and these leads to quick depletion of an energy level which reduces the network lifetime. This usually occurs for large scale and random deployments of WSNs. Hence, load balancing is quite essential to enhance the network. The load balancing can be done by constructing the dynamic cover tree.

The Dynamic cover tree can be constructed by using the following properties:

- ✓ The leaves of the trees will always be sensing nodes, the energy waste can be avoided if connectivity does not exist between sensing nodes;
- ✓ The base station is the root of the tree
- ✓ At least one of the sensing nodes can be covered by tree
- ✓ Both sensing and relaying tasks simultaneously cannot be performed by a sensor node

The cover tree (fig 4.1) contains sensing nodes and relaying nodes in a dynamic manner. The sensing node has to transmit its sensed data to the base station neither through relaying nodes nor as in a direct manner. These Dynamic cover trees use only fewer sensor nodes for transmission and reception by checking the following three conditions: 1. queuing list of the buffer, 2.the current status of nodes (i.e. either node is in an active state or inactive state) and 3.residual energy of sensor nodes.

Using this information network updates the neighbor's information and transceivers the data through a minimum traffic area and it reduces the network traffic burden. It will help to maintain the load without losing the coverage and connectivity without losing a traffic burden at nodes.

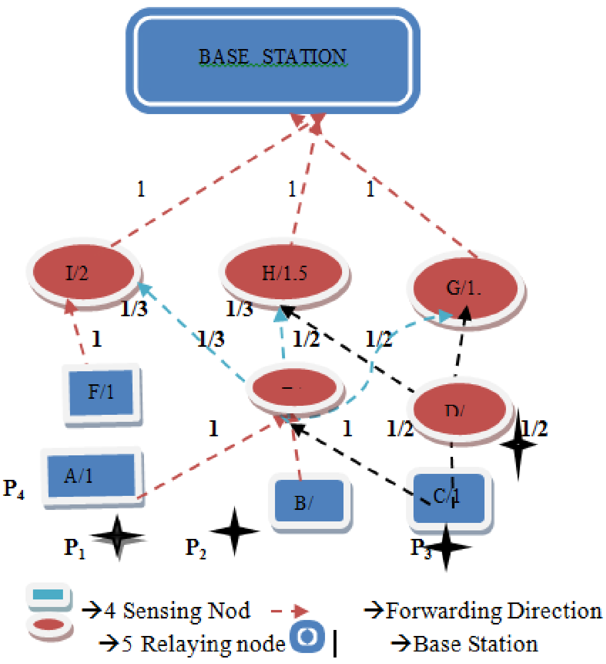


Fig 4: Calculating the expected load in the dynamic cover tree

Table 2: Evaluation Parameter

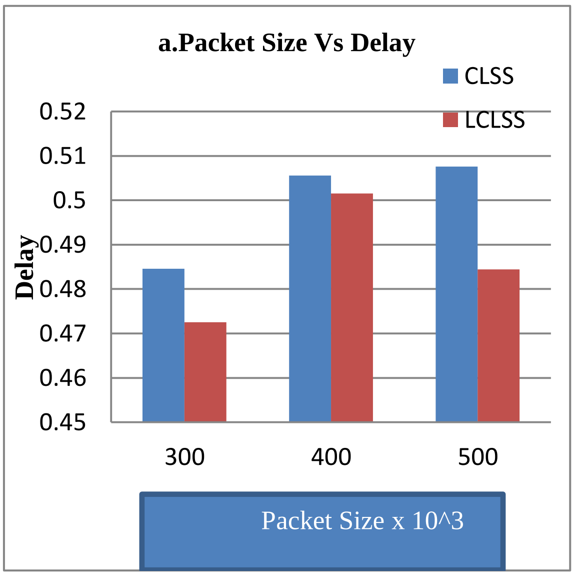
Parameter	Parameter Value
Number of sensor nodes	100
K in EC-CKN	2
Number of Packets	1000
Time epoch interval	1 minute
Hello interval	5μs
Network diameter	30
Threshold value	7
Node interval waits time	0.03μs
Local repair waits time	0.15μs
Packet length	12bytes
Network radius	60m
Delay	1μs

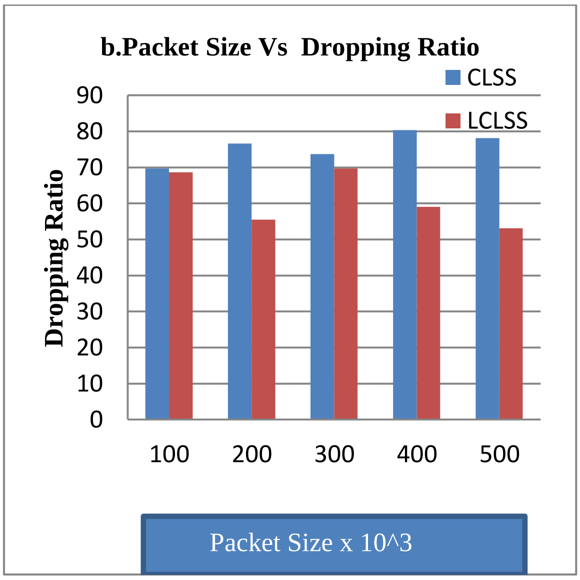
V. RESULTS AND DISCUSSION

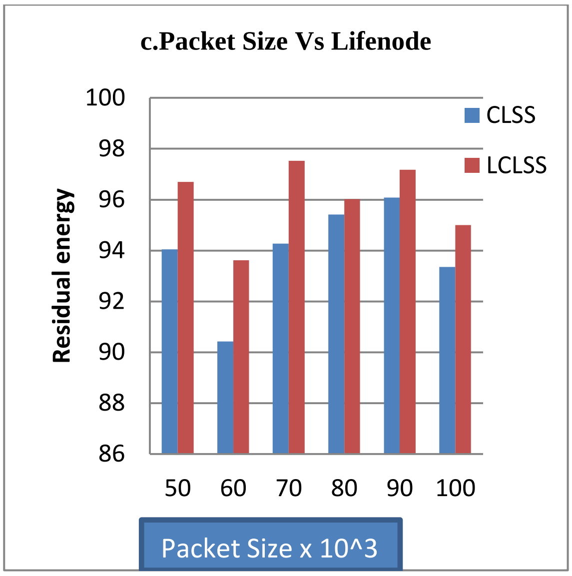
The simulation analysis for network lifetime, throughput rate, and residual energy, dropping ratio, packet delivering ratio and delay are compared with the CLSS and LCLSS are shown below.

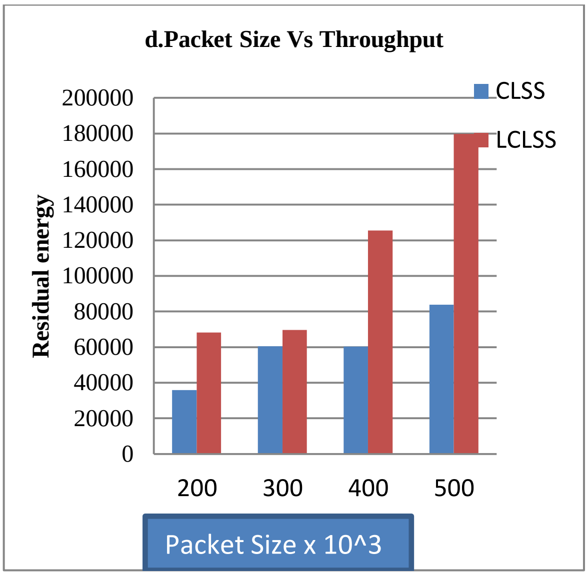
From fig 5.1 and graph (a), we can observe that LCLSS provides lower delay when compared with CLSS scheme, in this case, of CLSS all the data are transmitted over the fixed path only while in LCLSS the routing takes places over a lower traffic area and these leads to a reduction in delay.

In graph (b), dropping ratio of CLSS is compared with LCLSS; we obviously observed that the LCLSS shows the lower dropping ratio because CLSS schemes are fails to distribute the Load equally throughout the network. While the LCLSS Scheme concentrate on Load balancing using dynamic cover tree Scheme.









In graph (C) the comparisons are made between CLSS and LCLSS schemes based on network lifetime because most of the sensor are battery powered. So, it is essential to analyzing the network of the sensor and from the analysis, we observed that Load based CLSS shows higher network lifetime with normalized CLSS. This is due to wastage of energy is reduced through proper planning of load throughout the network. From the graph (d), the comparison is shown for throughput, the LCLSS schemes have higher throughput when compared with CLSS Scheme. This is because the LCLSS schemes are more reliable and it provides the fast response to the unexpected traffic and load.

Finally, at the graph (e), the Packet delivering ratio of a sensor is compared and obviously those LCLSS schemes have maximum PDR when compared with others because the CLSS Scheme is Prone to Load and Congestion also occurred while transferring the data. The CLSS Scheme is free from this problem. From the analysis, it is cleared that the overall performance of integrated WSN-MCC schemes is improved when comparatively with older CLSS Scheme.

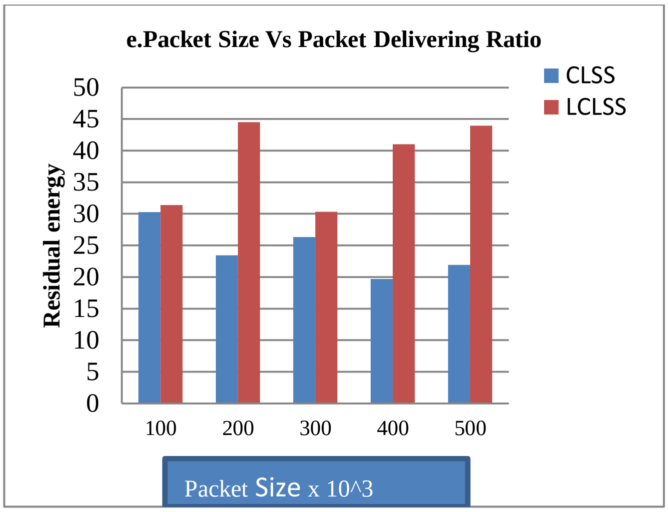


Fig 5: Simulation analysis of Existing CLSS with Proposed LCLSS scheme:
a. Delay b. Dropping ratio c. Life nodes d. Throughput e. PDR

VI. CONCLUSION

This Paper introduces a new novel approaches known as Load balanced collaborative location-based sleep scheduling (LCLSS) schemes. This Scheme is purely based on the Scheduling with equal distribution of nodes through the low traffic area. The sensor node has been dynamically devised by Schedulers using traffic level. By doing this, we can reduce a large amount of energy wastage, delay and drop ratio. Similarly, PDR and Throughput at sensor nodes can be maximized. CLSS work depends on the status of the node, residual energy and size of the buffer. Finally, it is cleared that the overall performance of integrated WSN-MCC schemes is improved when comparatively with older CLSS Scheme.

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