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# Sleep scheduling with load balancing in sensor-cloud based on mobile user location

Priya R, Mahendran N

1. PG Scholar/Dept of ECE, M.Kumarasamy College of Engineering, Karur, Tamilnadu, India
2. Assistant Professor/Dept of ECE, M.Kumarasamy College of Engineering, Karur, Tamilnadu, India

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## ABSTRACT

The mobile cloud computing (MCC) with wireless sensor networks (WSNs) technology gets a more attraction by researchers, because its combines the data gathering ability of sensors with the data processing capacity of the cloud. This new approach overcomes the limitation of data storage capacity and computational ability of sensor nodes. Finally, the stored data are sent to the mobile users when the user sends the request. The most of the integrated sensor-cloud schemes fail to observe the following criteria: 1) The mobile users request the specific data to the cloud based on their present location 2) One of the predominant issues in WSN is power consumption since most of them are equipped with non-rechargeable batteries. Mostly the sensors are deployed in hazardous and remote areas. This paper focuses on above observations and introduces the novel approaches known as collaborative location-based sleep scheduling (CLSS) schemes. 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 with load balancing; in this manner, the performance of WSN is increased.

Index term- Sleep Scheduling, Mobile cloud computing, wireless sensor network, integration, location, Discrete Point of Interest

# 1. INTRODUCTION

## 1.1 *Wireless Sensor Networks (WSNs)*

Wireless sensor network consists of diverse with a wide number of autonomous sensors nodes to cooperatively work together and gather various physical and environmental parameters such as humid, gas, light [1]. The deployments can be made either uniform or random manner. The traditional way for people to interact with the world is changed by the sensor. WSNs have been the research focus of both academic and industrial communities to explore their great potentials in the industrial and civilian applications (e.g., military, agriculture field, and forest area monitoring and fire detection).In smart agriculture, a WSN node can be utilized in the environmental detection system to detect the moisture level of soil as well as other changes in various parameters. It is possible to predict the health condition of a plant. In addition, with respect to sewer overflow detection, a number of distributed sensor nodes can be deployed at various points in a pipe, watershed or lakes to monitor the water quality, and accurate level of the water status can be created without using manual data retrieval, especially with difficult accessing location. Basic units of the sensor are the processor, memory, radio transceiver, power source. The processor is application specific and Global Positioning System (GPS) is used for transmission purpose.

## 1.2 *Mobile Cloud Computing*

The Cloud Computing is an innovative technology that provides shared computing resources instead of having private servers or personal devices to handle applications. The Cloud Computing is similar to Grid Computing. The Grid Computing includes multiple nodes from various locations which are connected together for common goal. In Cloud Computing, the word cloud is used as an analogy for "The internet''. Cloud Computing refers to the "internet-based computing type'' [2]. It is used to connect the low -level consumers with minimum cost. Depending upon the user needs, they provide services. Mobile Cloud Computing supports both the data storage and the data processing happening at an outer environment of the mobile device. Computing process and data storage will be done at the cloud in Mobile Cloud Computing applications. This application is applicable to a broader range of mobile subscribers [3] [4].

## *1.3 Integration of MCC and WSNs*

The Integration of WSN-MCC is a newly emerged technology that collaboratively combines the data gathering ability of sensor with the data processing capacity of the cloud as shown in figure1.The Cloud provides large storage capacity and with computational ability. The Sensed data from the sensor are decompressed at the sink and sent to cloud gateway [5][6]. In cloud data compression takes place and compressed data is stored there. The stored data is sent only to the mobile user, who sends the request message to the cloud.

## *1.4 Scheduling and Load Balancing*

In general, the scheduling is to arrange or plan things that take places within a particular time. The proper scheduling will reduce the power consumption and extending network lifetime.

# 2. LITERATURE REVIEW

Power management is vital because sensors are battery powered. Sleep scheduling reduces the power usage by implementing the idea that power sensor is in awaken stage at a particular instant of time (e.g. detection) and sleep at rest of time. Even at sleeping state, sensor consumes energy. But it is analogously lower than in other stages (i.e., an idle state waiting for stage and transition stage).For instance, an Adaptive partitioning scheme is used for reducing the energy consumption is presented in [7]. A group of sensors is partitioned and connected backbone network can be managed by keeping only one willful node from each group in the active stage while remaining nodes is maintained in sleep stage and it does not depend on nodes location. In adaptive partitioning scheme, the designed node scheduling with topology control with NP-hard problem as a constrained optimal graph partition problem is formulated by Connectivity Partition Approach (CPA), where node connectivity is done by merging process. During the merging process, two adjacent nodes with the highest priority will be merged together. This merging process continues until paired data meets the energy constraint. The decision is made based on highest priority. In [8], another approach for sleep scheduling using Energy efficient wake-up protocol is discussed. A sensor periodically produces data as it monitors the environment in WSN. In this protocols for low-data-rate WSNs, where the sensors energy consumption level differs from state to state while transmitting, receiving, listening, sleeping, and being idle. The sensors consume energy for state transition. In such case MAC layer protocol is scheduled with TDMA and it reduces the number of state transitions through schedule the sensor nodes with a consecutive time slot. This scheduling also optimizes the energy consumption of both homogeneous network and heterogeneous networks. In [9] also proposed a sleep scheduling with Distributed activity scheduling algorithm is discussed. In this algorithm, a major asset of

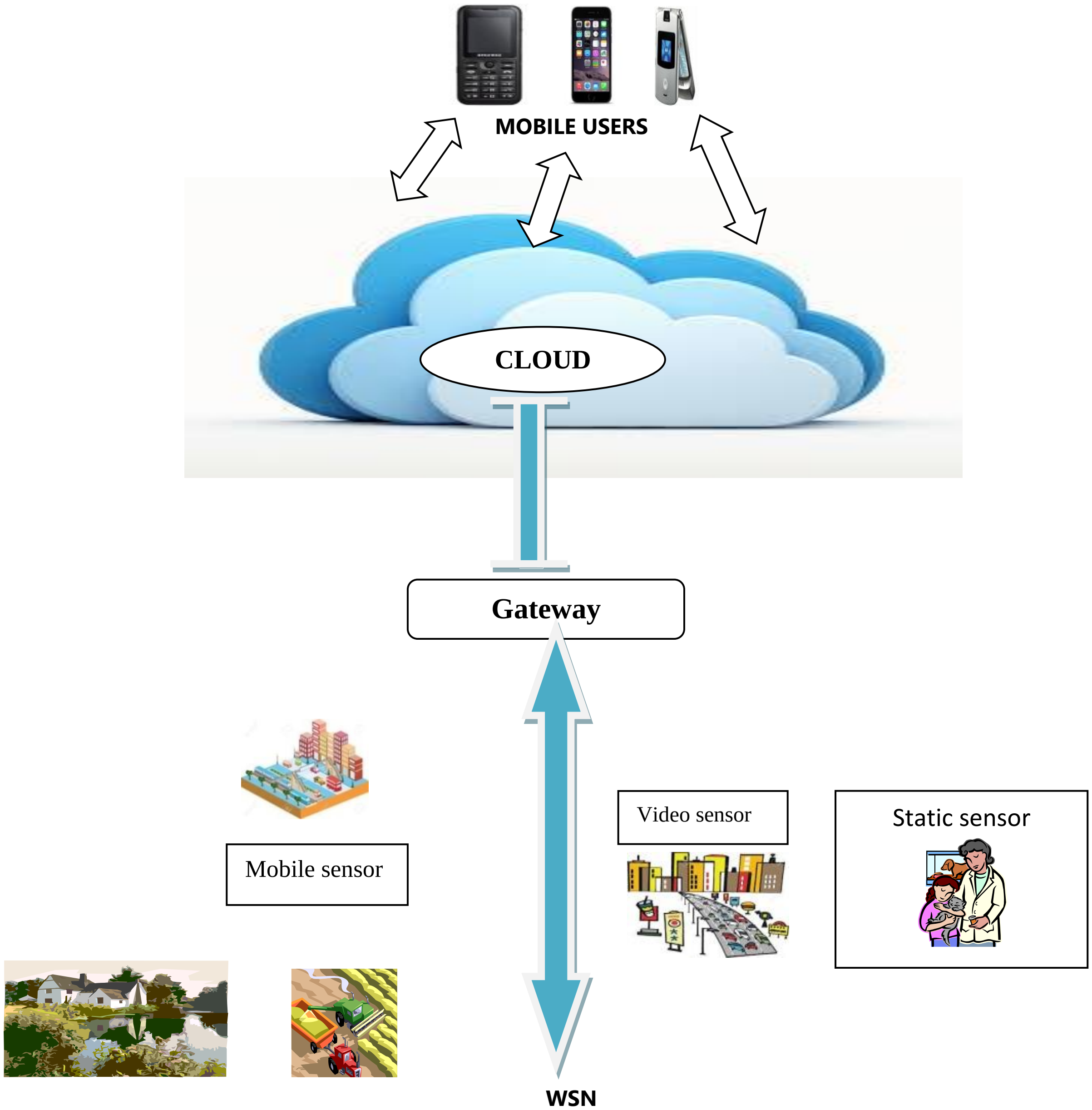



**Figure 1** Example of MCC-WSN Integration

partial coverage with Distributive Adaptive Sleep Scheduling Algorithm (DASSA) is maximizing the network lifetime. DASSA maintaining connectivity and user defined coverage target without the use of location information. In this method, the sink nodes distributed the residual energy levels and feedback to neighboring nodes. This feedback methodology in DASSA scheduling reduces the randomness in scheduling because it occurs in the absence of location information. Through DASSA, network lifetimes can be achieved up to 92%. The new scheme for Sleep Scheduling is introduced at [10], It schedules the nodes that are eligible to sleep (i.e.) scheduler decide which node is to be in a power-saving mode to save network coverage and energy. RBSS does not need location information of the sensors nodes. It gathers only the distance information between the two sensors. In RBSS approach demands the fewest working (awake) sensors and it takes only optimal selection pattern. In [11], A Multi-objective (MO) online, an optimization algorithm is used to schedule the nodes efficiently to increase the lifetime of sensors. The MO algorithm deals with differentiated or probabilistic coverage to sense different region with different levels, hence, they differ from traditional grid or uniform coverage. It shows better concession among energy consumption, lifetime, and coverage. Rescheduling occurs when a node failure emerges. From the survey, we studied various sleep scheduling algorithms are discussed in terms of energy consumption. The Sleep scheduling algorithm is used to balance sensor node's energy consumption and a reasonable length towards energy saving while deploying WSNs for practical applications. It helps to maintain the required energy consumption and produces very high network lifetime than the traditional deployment schemes. The storage capacity is still lagging in WSN, in order to overcome this, the new approach termed as Integration of WSN with Mobile Cloud Computing (MCC) as a solution to the above problem.

## 3. OVERALL SYSTEM MODEL

Consider, N number of sensors (i.e.wsn1 wsn2 wsn3 …wsn-1) deployed at the environment with multi-hopping along with N number of mobile users (i.e., U1, U2, U3 ….Un-1 ) at the receiving side. The cloud acts as a bridge between the mobile users and WSN. If data request issued by any mobile user, cloud sends the corresponding stored information. The information is gathered from WSN by a cloud. In the case, if any mobile user has provided with the global positioning system (GPS) then the mobile user make use of the StarTrack service [12]. The gateway between each WSN and the cloud act as a base station(s).The base station is powered with unlimited energy supply. The Scheduling is done based on the location of a mobile user list using time (T) and it is divided into time epochs with the interval (t).

### *Overall WSN model*

The multi-hop sensors are either uniformly or randomly deployed with N nodes in a two dimensions area A. The hopping existing between any two neighbors only if they presented within the transmission range, otherwise they look for new one.

### *WSN Energy Model*

The energy used by a sensor to transmit and receive one byte, and the power required to amplify each transmitted byte to cover the distance of 1m is used to calculate the WSN energy model. This includes the packet header and sensed data. The energy consumed to transmit and receive a packet of length (h) bytes over distance (d).

Transmitted energy ($E_T$):
$E_T = e_t + e_a * h * d^2$ ------------------> (3.1)
Received energy ($E_R$):
$E_R = e_r * h$ -------------------> (3.2)
Where
$e_a$ = energy consumption of power amplification
$e_t$ = energy consumption of transmitting a byte
$e_r$= energy consumption of receiving a byte

### *WSN Event Model*

characterizable distribution in space and time is used in the event model. The sensing is done at sensors node when a sensor node receives a signal with power above a predetermined threshold. For an instant, a Poisson process takes place for the temporal event behavior with an average event rate over the entire sensing region and an independent probability distribution is used for events of the spatial distribution.

## 4. CLSS SCHEME

In this section, we initially show the mechanisms to obtain the location list of mobile user and later on CLSS schemes (fig 2).

### Mobile user location list

In order to get the location list of the mobile user, the location history of a user is gathered by the cloud. The clouds do this work using Star Track service used by a mobile client application. It periodically captures the user's current location using GPS or some other source and then the captured information are transferred to the star track server which runs as a service on the cloud server. Additionally, they process the collected location data and break down into various tracks (i.e., 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 used to obtain the mobile user prediction location list. The key idea behind that, the future locations of the mobile user would depend upon the frequently visited locations list of the user. The future track of the mobile user will be aggregated by these frequently visited locations. Finally, the location lists L of the mobile users are cumulatively formed from the mobile user location history list and mobile user prediction location list.

### *CLSS1*

The CLSS1 scheme, the mobile user current locations are first obtained by the cloud, then cloud decides either a Flag A or Z is sent to base station depends on the user location list L. If cloud sent flag A from the base station it's maintained at the awakening state and broadcasting the flag to all the sensor nodes. Otherwise, they go to the sleep state.

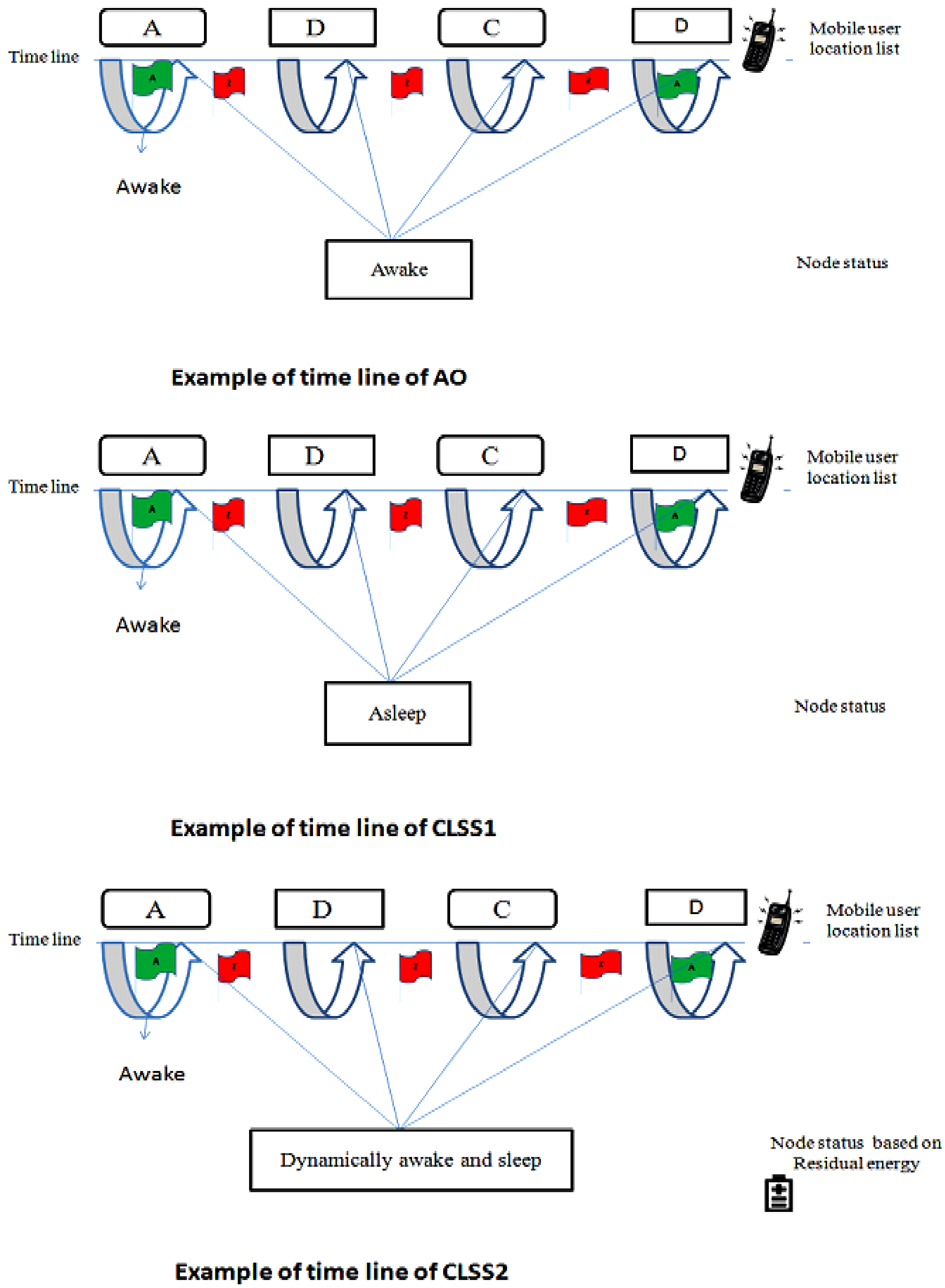



**Figure 2** Schematic Representations of AO, CLSS1, CLSS2

*CLSS2*

Both CLSS1 and CLSS2 scheme works as same, but the only difference occurs while they receiving flag Z. CLSS1nodes go to sleep state when they receive flag Z while at CLSS2 nodes will enter into a sleep state by using energy consumption based connected K-neighborhood (EC-CKN) sleep scheduling scheme. The EC-CKN scheme works based on the residual energy (Erank$_i$) of the sensor nodes. Before they enter into a sleep state, the sensor nodes broadcast their residual energy and receiving from others. After receiving the information decision only if they satisfied 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.

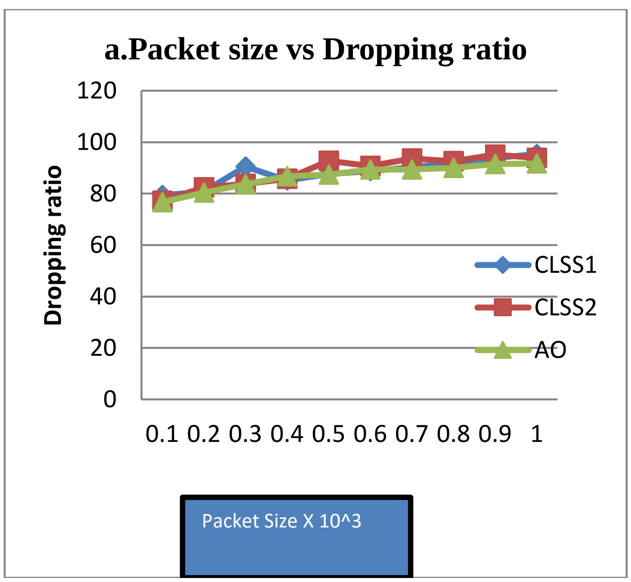
**Table 1** Evaluation Parameter

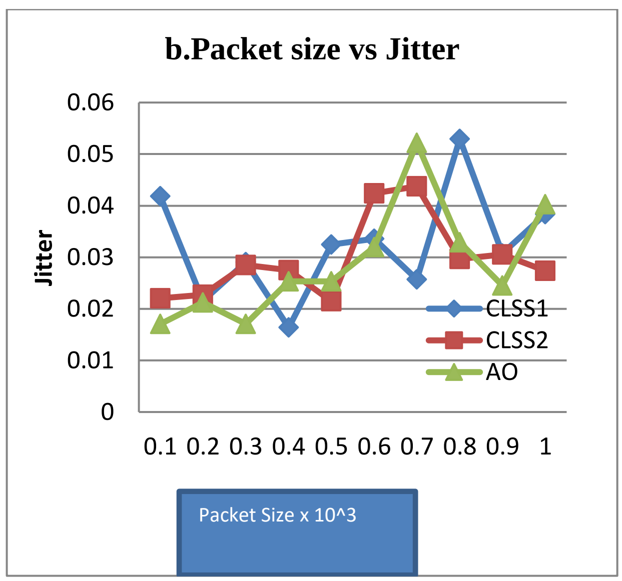
| Parameter | Parameter Value |
|---|---|
| Number of sensor nodes | 100 |
| K in EC-CKN | 2 |
| Number of Packets | 1000 |
| Time epoch interval | 1 minute |
| Hello interval | 5μs |
| Network diameter | 30 |
| Threshold value | 7 |
| Node interval waits time | 0.03μs |
| Local repair waits time | 0.15μs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

## 5. RESULTS AND DISCUSSION

The simulation analysis for network lifetime, throughput rate, residual energy and delay of CLSS1, CLSS2 as well as AO for mobile user1, mobile user2, and mobile user3 are shown below. From fig 3 graph (a), observe that AO provides lower dropping when comparatively with both CLSS1 and CLSS2 because the AO is always maintained to be waking state in order to transceiver the data from a cloud to the sensor networks and vice versa.Hence, there will be a possibility of data loss.In the graph (b), Jitter is compared and from that, both CLSS1and CLSS2 have higher Jitter comparatively with other schemes. Among them AO has the least jitter, this is because of the AO is always maintaining at active state while CLSS scheme maintaining only if it receives a flag.

From the graph (c), the Packet delivering ratio of a sensor is compared and obviously those CLSS schemes have maximum PDR when compared with others because the AO Scheme is Prone to Load and Congestion also occurred while transferring the data. Finally, at the graph (d), the comparison is shown for Residual Energy, the CLSS1, and the AO schemes have higher throughput when compared with CLSS2 Scheme. This is because the AO schemes are more reliable and it provides the fast response to the unexpected mobile user requesting. In such case the nodes are maintained at awakening state, even the mobile user are not in the listed location. This makes an AO node energy level is always shown in the lower state.



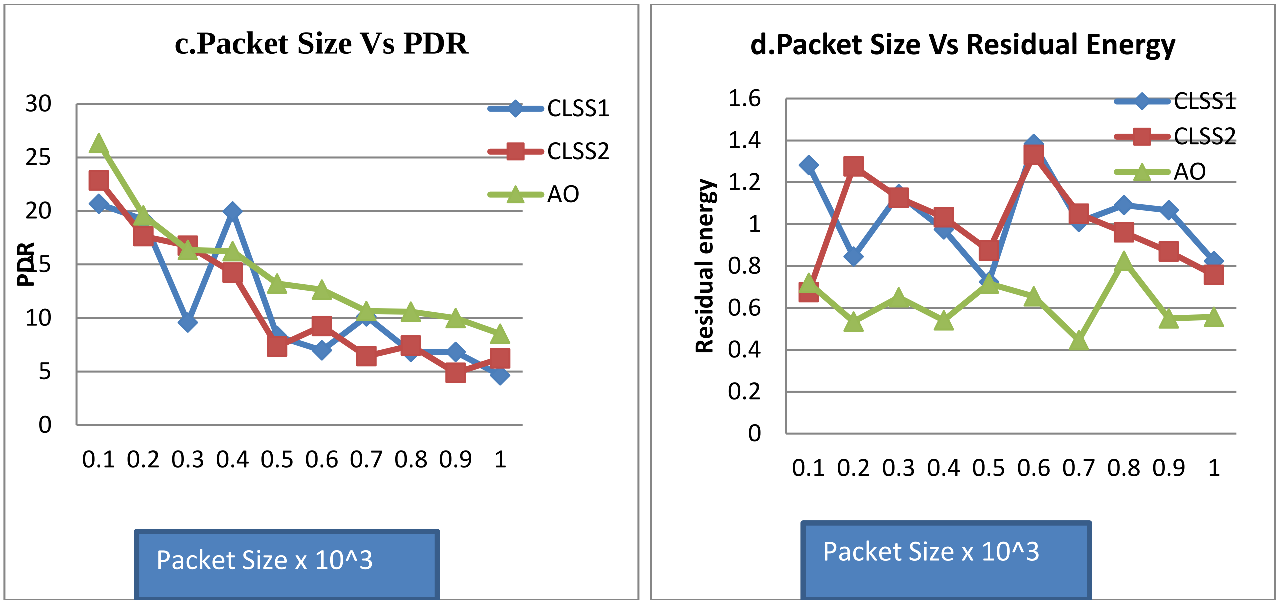



**Figure 3** Simulation analysis of AO, CLSS1, CLSS2: a. Dropping ratio b. Jitter c. PDR d. Residual Energy

## 6. CONCLUSION

This Paper introduces a new novel approaches known as collaborative location-based sleep scheduling (CLSS) schemes. This Scheme is purely based on the current location of mobile users and Scheduling. The sensor node has been dynamically devised by Schedulers using these location lists. By doing this, can reduce a large amount of energy wastage at sensor nodes. CLSS work depends on two novel approaches; from that CLSS1 scheme provides reduced energy consumption and CLSS2 afforded the scalability and robustness of the integrated WSN. Finally, some interesting problems are chosen for our future work. First one is authentication Problems and another one is based on load management at sensor network.

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