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# SCLSS: SECURED COLLABORATIVE LOCATION DEPENDENT SLEEP SCHEDULING FOR WIRELESS SENSOR NETWORKS INTEGRATED WITH MOBILE CLOUD COMPUTING

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***ABSTRACT***

The recent trends has presented the integration of Mobile Cloud Computing (MCC) and Wireless Sensor Networks (WSNs) as the powerful technique and beneficial in a collection of data from WSNs and sharing with clients. However, the integration model of MCC- WSNs notices the following aspect. The particular information from the clients are dependent on the client's current locations and almost all the sensor nodes have insufficient energy with non-rechargeable battery, and they are not secured when they have low energy. In this paper, considering the above aspect, a Secured Collaborative Location Dependent Sleep Scheduling (SCLSS) for WSN Integrated with Mobile Cloud Computing has been proposed. Depending on the client's location, the primary focus of SCLSS is to provide security for the WSNiich are integrated with MCC. Simulation results show that WSNs which are integrated with MCC are secured and offer the maximum lifetime and increases the throughput and packet-delivery-ratio.

Keywords—*Secured Collaborative Location Dependent Sleep Scheduling, Wireless Sensor Network, Mobile Cloud Computing, Integration.*

## I.INTRODUCTION

### *A.Mobile Cloud Computing*

Cloud Computing is a technology which makes use of storehouses rather than hard drives and personal computers which can be used at any time and everywhere, which performs the applications like sharing the information or data and retrieving the environmental data [1]. Mobile Cloud Computing is a technology in which the integration of mobile networks and WSNs are used to provide the advantages for clients as well as the cloud providers or owners. It has a simple infrastructure where both storing and processing of data can be done on the mobile platforms [2]. The technology of Mobile Cloud Computing (MCC) helped to minimize the consumption of energy of mobile devices and also offered many mobile services like data resources regarding the education. The speed of the process is slow, and the cost is maximum for storage on the mobile devices. Exporting these platforms of learning to the cloud, teachers, and learners can obtain high processing speed and a large number of resources [3].

### *B. Wireless Sensor Networks*

A Wireless Sensor Network is a group of specialized transducers with a communications infrastructure for monitoring and recording conditions at diverse locations. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, illumination intensity, vibration intensity, sound intensity, power-line voltage, chemical concentrations, pollutant levels [4].

### *C. Motivation*

The integration of MCC-WSNs schemes has the following issues.

1. Considering an example of the applications like work schedule over the internet is useful only when the clients are going to work, but it is not useful when the client is in home or at hotel, similarly when the client retrieves the information from the traffic applications, it is useful only when the client is going to

 

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that place or region. So in these cases, the client's current locations are ignored and also some of the applications like navigation provide the guidance about the direction to the user to travel to those places.

2. Almost all sensor devices are having the non-rechargeable battery with restricted energy, so these might be dead and having a very short lifetime and not secured when they have less energy.

*D.Research Contribution*

In this paper, an algorithm Secured Collaborative Locations Dependent Sleep Scheduling (SCLSS) for WSNs integrated with MCC has been proposed. By considering the client's current location, the sensor nodes changes its status (eg: awake or sleep status) in the networks to minimize the consumption of energy. Therefore the main focus of SCLSS is to provide security to the WSNs which are integrated with MCC and increases the lifetime of the WSNs and thus increase in throughput and packet delivery ratio.

The organization of this paper is as follows. Section 2 discusses the related works which are used in this paper for implementation. Section 3 presents the model for integration of MCC-WSNs. Section 4 introduced the proposed algorithm for SCLSS. Section 5 gives the performance matrices used for analysis of the proposed algorithm. Conclusions are discussed in Section 6

## II. RELATED WORK

Buyya *et al*.,[1] created the model for market-oriented allocation of resources within the cloud and for the services created the cloud of exchange over the world and provides the "storage clouds" with the help of cloud computing. Dinh *et al*., [2] have overcome the issues such as performance, environments, and security by combining the cloud computing and mobile cloud computing and increase the growth of its applications. Wang *et al*., [3] discuss the mobile cloud computing supports for multimedia applications like mobile gaming, mobile cloud healthcare, mobile cloud learning..etc. This has shown that it supports all kinds of mobile services.

Akyildiz *et al*.,[4] presented the architecture for wireless sensor networks in which it contains set of different sensor nodes which are placed in environment which are helpful to observing the variety of conditions like temperature, humidity, vehicular movement, lighting conditions, soil makeup, noise levels, pressure, the presence of or absence of certain objects, observing and helpful in military applications, battlefield surveillance, health applications, home applications, and other commercial applications. Zhu *et al*., [5] discussed the WSNs communication and the issues regarding the data management into the sensor networks for the mobile and solved the issues such as topological issues where it has assigned the transmission power to stay the network linked to reducing the consumption of energy of the sensor nodes. Also, It solves the coverage issues localization issues, target tracking issues, data management issues such as data gathering issues, data replications, and other open problems.

Zhu *et al*., [6] presented a framework for integration of mobile cloud computing and wireless sensor network which has the main focus to transmitting desirable sensory data to the client in fast and reliable and secure manner. It reduces the data traffic load and resolves the data security issues. Zhang *et al*.,[7] developed the model based on cloud computing for wireless sensor networks which helps to improve the performance of Wireless Sensor Networks. Ahmed *et al*., [8] in this the data which are obtained from the next generation of the WSN were added to social network applications, virtual communities, and blogs. Therefore these data derived from the sensor network into the applications will provide the profit to the technologies which are being developed for the purpose of emerging cloud computing technologies. Lee *et al*.,[9] discussed the benefits and feasibility of mobile cloud computing integration wireless sensor networks, The paper presented Amazon EC2 to solve the challenges, feasibility, releasing computational elasticity in Amazon and provide resources flexibility. These allow user to launch and manage virtual machines on Amazon infrastructure through web service APIs and tools, web-based management console. It provides services such as pay per use for this user must be created their account in Amazon EC2 to use it and provides built-in support for dynamic loads or changes. Amazon EC2 automatically controls the instances and reduces the overall cost of deployment. Sayantani Saha *et al*.,[10] discussed the model for WSNs based applications integrated with cloud computing which provides fast and secured data transmission to the clients. The data model mainly focused on data flow, data processing and the Security model which mainly provides security to the cloud from malicious attack.

Stuedi *et al*.,[11] presented the concept of Wherestore technology, which helps in the location based data storage for the smartphones which will interact with the cloud. The Wherestore services resolve data access locally and consist of history of the clients based on the clients requested data, and can find out their future locations for any other information if it is needed. Meier *et al*., [12] discussed about requirements of the collaborative mobile applications support event based communications in the network. It provides the technologies which are aware of locations as well as mobile applications such as location independent

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announcement and location based event filtering, subscriptions, distributed event services. Gonzales *et al*.,[13] proposed model for providing reliability to Common Channel Signal (CCS) from network backers it is used calculator the security level of four multilayer of IaaS(Infrastructure as a Service)cloud architecture and showed the probability of CCS for large amount of data is higher if it is having finite number of security controls. Yufeng *et al*., [14] presented a Malguki algorithm with range free centroid localization, which initially takes the positions of which are unknown sensor node and finds the location of it and reduces the cost.

You *et al*.,[15] presented the security model which introduces identity and authentication unit which provides the application services such as user registration, user login, authentication protocol etc., which make use of the data encryption and data decryption algorithms to provide the reliable security to the database. Xie *et al*., [16] discussed the uses of intelligent security system which helps to solve the issue occurred in a wireless security system and maintains load consumption which leads to low energy consumption. These make use of cluster-based selection algorithm, which helps in high velocity moveable, low energy consumption and low cost. Tekeoglu *et al*., [17] mainly focused on investigating security using network security of the multiple access to banks, office, hotels, temple etc. It is easy to setup and they have provided controlled access to the mechanism, recognizes the issue of privacy, security and find out the malicious person. Lounis *et al*.,[18] mainly focused on secure and scalable architecture for emergency situations which make use of attribute-based encryption by using the concept of cryptography.

Zhu *et al.*, [19] discus Zigbee and Global Protocol on Packing Sustainability (GPPS) protocols which support the IoT application scenarios, requirements from the data transmission between Web Service (WS) and mobile network and provide the validation. IoT gateway mainly acts as the transmission medium between two different medium. Kapadia *et al*., [20] propose computational networking and sensing model for the large scale mobile phone-based sensor network. They have solved the issue such as i) Risk analysis which means environment and control the mobile sensor. ii) New viruses and defense installed on the sensor network. iii) Analysis for converting channels being used to avoid encryption in the cloud interface.

## III .SYSTEM ARCHITECTURE

The system architecture of integration of Wireless Sensor Network with Mobile Cloud Computing is as shown in Figure 1. Cloud collects the data requested by the client. Depending upon the locations of client the cloud transmits the requested data to sensor nodes, the sensor nodes collects the requested data and sends the response to the cloud depending upon the locations of the clients. The cloud sends this response to the clients. Table 1 gives the Notations used in this paper.

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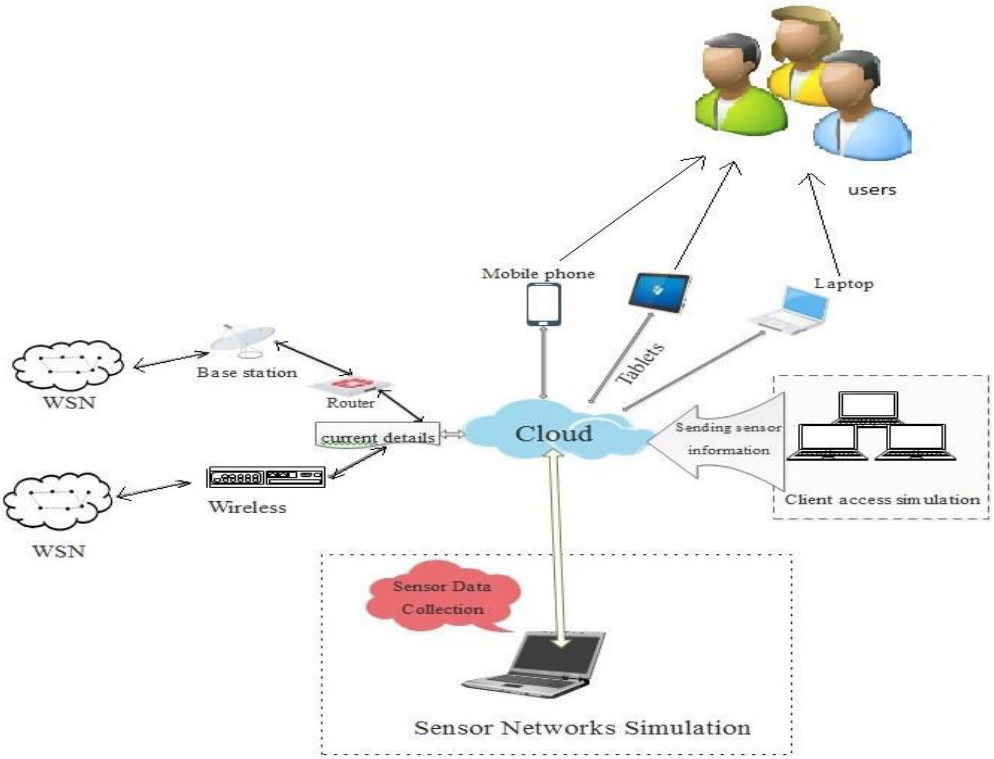


**Figure 1.Example of Integration of Wireless Sensor Network with Mobile Cloud Computing.**

***A.Overall Description of System Model***

Consider "c" as a cloud and there will be "M" number of clients noted as (i.e u1,u2,u3,…..uM) and also considering "M" as the multi-hop for WSNs noted as (i.e wsn1,wsn2,….wsnM). In the network, the source of data will be obtained from the WSNs for the clouds. So that cloud can respond to the requested data which are retrieved from the client. It assumed that the client's devices make use of GPS system and the internet services. "s" is considered as a base station in the network which acts as the gateway in between the cloud and WSNs that have limited energy. "T" is the time which divides into epochs of time. "TP" is the time epoch and time epoch interval is considered as "t".

***B. Overall Model of WSN***

"A" is the area in that "N" is the number of sensor nodes which are deployed randomly. The overall network is constructed as graph G = (I;B), in which I = {i1; i2; … ; iN} is considered a group of sensor nodes and B = {b(1;2); b(2;3); _ ; b(N-1;N)} is considered a group of links. Transmission radius of every node in the network is same for every node ii and ij are considered as neighbors when they are in the range of transmission medium and node ii and ij are considered as 2-hop neighbors only if b(ii;ij ) ∉ B. There will be one or more nodes "iw" in between such that b(ii;iw) & b(iw;ij ) ∈ B or b(ij ;iw) & b(iw;ii) ∈ B.

***C. Energy Model of WSN***

The consumed energy from a sensor node to transmit one byte and receive a byte and power amplification for transmitting a byte across a distance or region of 1m are et mJ, er mJ and ea mJ/m2 respectively. The sensed data contains a body of sensed data, the packet header, the energy which is utilized during transmission and reception of a packet. "h" is the length of packet and "d" is the distance. Energy Utilization of Sending a Packet and receiving a packet is ET, ER are calculated using equations (1) and (2).

$$E_T = e_t \cdot h + e_a \cdot h \cdot d^2 \quad (1)$$

$$E_R = e_r \cdot h \quad (2$$

**Table .1 Notations used in the paper**

| Symbols | Definitions |
|---|---|
| Symbols | Description |
| ‖ | Bundle of Variables In A Set |
| C | Cloud |

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| | |
|---|---|
| M | Bundle of Clients |
| U | Client |
| S | Base station |
| T | Time |
| TP | Time Epoch |
| T | Mean Time of Time Epoch |
| N | Overall Bundle of Sensor Nodes In Network |
| A | Region of WSN |
| I | Group of Sensor Nodes |
| B | Set of Connectors |
| $t_r$ | Radius of Transmission Medium |
| $e_t$ | Energy Utilization of Sending 1 Byte |
| $e_r$ | Energy Utilization of Getting 1 Byte |
| $e_a$ | Energy Utilization of Power Amplification A Byte To Surrounded By 1 M Distance |
| H | Height of Packet |
| D | Distance of Transmission |
| $E_T$ | Energy Utilization of Sending A Packet |
| $E_R$ | Energy Utilization of Getting A Packet |
| $\lambda$ | Median for Rate of Event |
| $L_h$ | History List of Client Location |
| $L_P$ | Prediction List of Client Location |
| L | Location List of Client |
| Packet-Error-Rate | Packet Error Rate during transmission |
| PDR | Packet Delivery Ratio during transmission |

## IV.PROPOSED CLASS SCHEMES

### *A. History List of the Mobile User Location*

"L" is the location list of the client "u". To obtain "L" the history of the locations of the user "u" is collected from the cloud "c" using the internet service. This cloud obtains the current locations of the client using GPS and stores in the cloud and then internet service divides the data of locations into records. These records form a list called as "Lh" history list of locations of the client.

### *B. Mobile Client Predication Domain List*

"LP" is the predictions of location list. To find out "LP" transition graphs are utilized. The main focus of the client future locations is that the client or user might visit those locations. The client future records consist of these locations which are frequently visited. For example, if the client goes from home "A" to institute "B" or to college "C" every day. Then it is sure that client will definitely go to either institute "B" or college "C" from home "A" in future.

Therefore "Lf" is the list of locations which are frequently visited by the client. These lists of locations obtained from calculating overall retrieved records and choosing the endpoints of these records of the clients. Later the updating of "Lf" is done by deleting the endpoints of these tracks which occurs only one time. Without using the starting point and end point of these tracks and which has to be unique and will form the prediction list of the locations of the user.

## V. ALGORITHMS

### *A. CLSS*

In CLSS, the threshold energy of sensor node is THE mJ which is minimum. In the first stage is the current location of "lu" of a client "u" is obtained by the cloud "c". The cloud checks "lu" is in the "L" or not. According to the result, it sends these flags (i.e flag A: a user is in the location list and flag Z: a user is not in the location list) to the base station in stage 2. Later flags are sent from the base station to the WSNs and set the status according to the flags in (stage 3 to stage 4). In stage 5, when these sensor nodes obtain the flag Z, then it will go to sleep to save the energy. It collects the remaining energy of the sensor nodes when Erank > THE in stage 6. Then in cloud "Ci" the subset of sensor nodes which are active should have Erank > Eranki . Before a

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sensor node goes to a sleep status in TP, that should hold two conditions 1) in "Ci" all the sensor nodes which are connected by neighbor sensor nodes should have Erank > Eranki 2) In cloud "Ci" all the neighbor's nodes should have at least K-neighbor nodes in stage 11.

***B. SCLSS***

In SCLSS, until stage 11 it is same as that of CLSS. The changes in CLSS and SCLSS are after the stage 11, after some time the cloud collects the current residual energy rank of the sensor nodes which are active in the network (i.e., C.Eranki > THE) in stage 12. And in cloud "Ci" the subset of sensor node which is active in the network should have C.Erank > C.Eranki, then it has to satisfy Erankj ≠ C.Erankj in stage 15. Then check these conditions C.Erank > C.Eranki and Erankj ≠ C.Erankj if it holds these conditions then remain awake or else delete the sensor nodes from the "Ci" and update the network "Ni" in stage 16.The threshold energy (THE) values is assume is minimum mJ in simulation.

**Algorithm of SCLSS**

Stage 1: Current location $l_u$ of client $u$ is obtained by cloud $c$.
Stage 2: *if* $l_u \in L$
*then*
$c$ forwards flag A to base station $s$
*else*
$c$ forwards flag Z.
Stage 3: Sensor nodes obtain flags from $s$.
Stage 4: execute Stage 5 at each node $i$.
Stage 5: *if* node $i$ get flag $A$
*then*
stay active.
else
Run Stage 6 to Stage 12. // Stage 6 to Stage 12 is the algorithm for energy consumption

Stage 6: Collect the Remaining energy $E_{ranki} > TH_E$.
Stage 7: Transmit $E_{ranki}$and collect the ranks list of its active neighbors $N_i$.
Let $R_i$be the set of these ranks.
Stage 8: Transmit $R_i$ and collect $R_j$ from each $j \in N_i$.
Stage 9: *if* $|N_i| < k$ or $|N_j| < k$ in favor of any $j \in N_i$
*then*
stay active&Go to Stage 12.
Stage 10: Calculate $C_i = \{j | j \in N_i$and $E_{rankj} > E_{ranki}\}$.
Stage 11: Go to inactive in case it holds the following conditions.

- In $C_i$considering two sensor nodes which are linked either directly or indirectly through nodes within $i$'s 2-hop neighborhood and the energy rank of these nodes should be greater than $E_{ranki}$.
- The sensor node which in $N_i$ should have at least $k$ neighbors in$C_i$.

//Stage 12 to Stage 17 is the Pseudo code of SCLSS
Stage 12: Collect the Remaining energy rank $C.E_{ranki} > TH_E$.
Stage 13: Transmit the $C.E_{ranki}$ and collect the rank list of currently active neighbors $N_i$.
Let $C.R_i$ be the set of these active neighbors.
Stage 14: Transmit $C.R_i$ and collect $C.R_j$ from each $j \in N_i$.
Stage 15: Compare$C_i = \{j \mid j \in N_i\ C.E_{rankj} \neq E_{rankj} < TH_E\}$
Stage 16: Change status of "$j$" node $\epsilon N_i$ and update $Ni \epsilon C_i$. // malicious node or virus attacked node.
Stage 17: Return

## VI. PERFORMANCE EVALUATION

***A.Simulation Setup***

| | | |
|---|---|---|
| Processor | : | 32 bit Operating System |
| Hard Disk | : | 20GB |
| RAM | : | 8GB |
| Operating System: | | Ubuntu |
| Language | : | C++ |
| Visual Interface | : | Command line / Terminal |

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IDE / tool : NS2.21

***B. Performance Matrices used for Analysis***

1. *Throughput:* It is defined as the overall packets delivered in a period over the transmission medium
2. *Packet_Error_Rate:* It is described as the ratio of overall errors packets at the receiver to the overall packets sent from the sender.

$$\text{Packet\_Error\_Rate} = \frac{\text{Total no of Errors occurred at Receiver}}{\text{Total no of Packet Sent from Sender}} \quad (3)$$

3. *Packet-Delivery-Ratio*:It is described as the ratio of overall packets that are obtained at the receiver to the overall packets that are sent from a sender to a receiver.

$$\text{PDR} = \frac{\text{Total no of Packets Received at Receiver}}{\text{Total no of Packets sent from a Sender}} \quad (4)$$

***C. Performance Analysis***

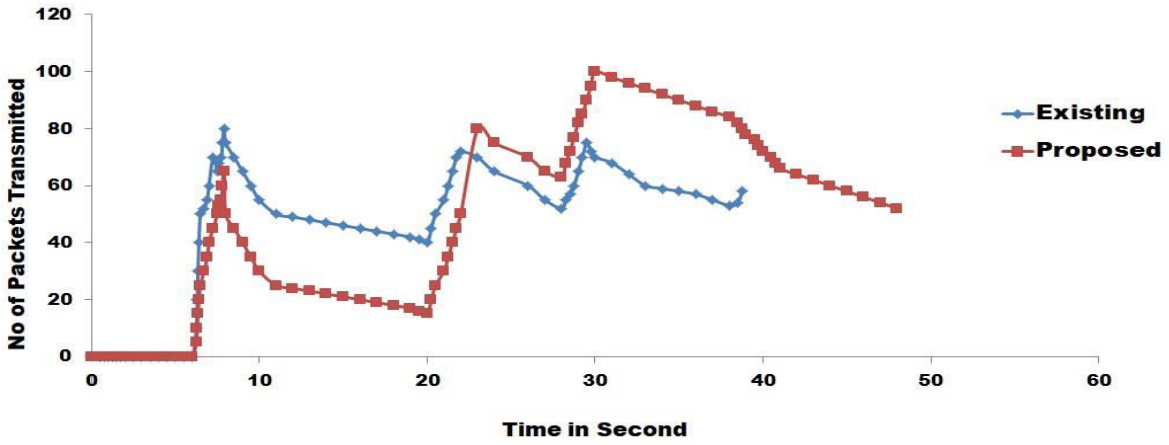


**Figure 2: Throughput**

Figure 2 shows the throughput of the existing algorithm CLSS and the proposed algorithm SCLSS. In the Existing algorithm and proposed algorithm throughput is almost similar when the energy of sensor node is above the threshold, the sensor node is secure. In existing system CLSS, we are not identifying sensor node which is having residual energy below the threshold energy, so the energy of sensor node drains faster, and this sensor node drains off, and there is no packet transmission. In the proposed system SCLSS, we are identifying the sensor node by comparing the residual energy of sensor node with threshold energy, if residual energy lesser than threshold energy changing its status to inactive to increase the lifetime of sensor node, so there will be a packet transmission in the network and there might be a packet loss in the network which leads to the number of packets transmitted to the client or user is less from starting., so throughput is reduced.

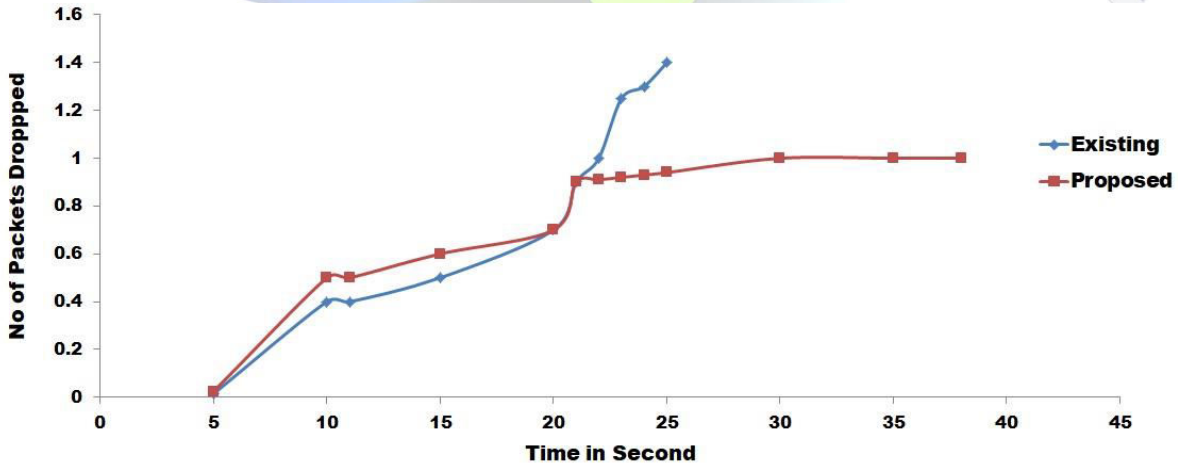


**Figure 3.Packet Error-Rate**

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Figure 3 shows the Packet error rate of the existing algorithm (CLSS) and proposed algorithm (SCLSS). In the Existing algorithm and proposed algorithm, Packet-Error-Rate is almost similar till the energy of sensor node is above the threshold and the sensor node is secure. In existing system CLSS, we are not identifying sensor node which is having residual energy below the threshold energy, so the energy of sensor node drains faster. As there is no packet transmission, there will not be packet loss beyond 25 seconds. In the proposed system SCLSS, identifying the sensor node by comparing the residual energy of sensor node with the threshold energy, if residual energy is lesser than threshold energy changing its status is changed to inactive to increase the lifetime of a sensor node. As there is packet transmission, there will be packet loss beyond 25 seconds. It is observed that the lifetime of the existing algorithm is around 25 seconds. Whereas the lifetime of the proposed algorithm is 40 Seconds, thus network lifetime is increased.

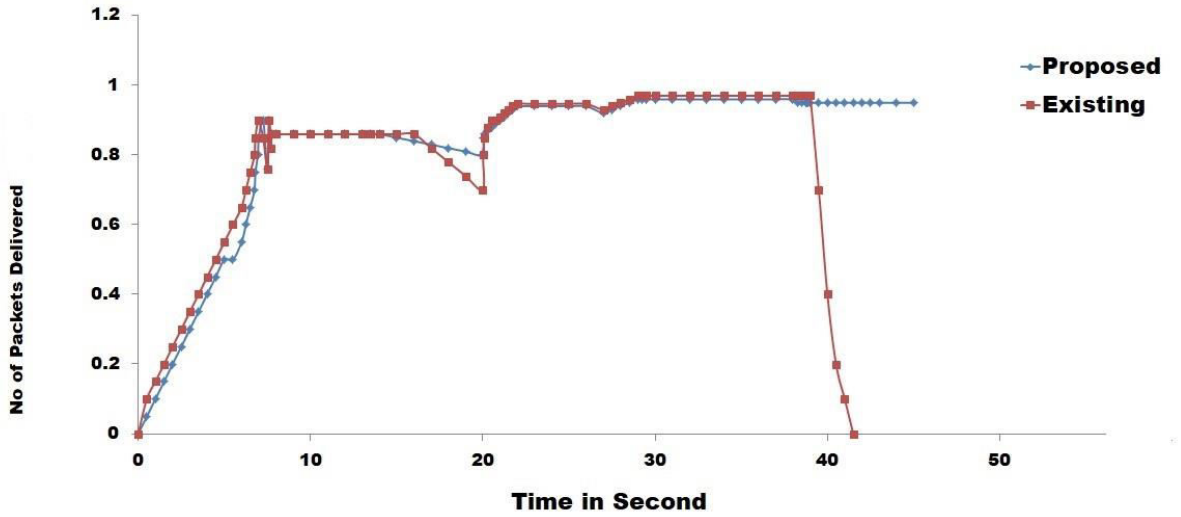


**Figure 4.Packet-Delivery-Ratio**

Figure 4 shows the Packet delivery ratio of the existing algorithm (CLSS) and proposed algorithm (SCLSS). In the existing algorithm and proposed algorithm, the packet delivery ratio is almost similar when the sensor node is above the threshold energy. when the sensor node energy is below the threshold energy, then there will be chances of a malicious attack on sensor node After a certain period there is no packet delivery in the existing algorithm as the network is dead because of the malicious attack on the sensor node, so there will no packet transmitted. But there will be accurate packet delivery in proposed algorithm after a certain period when a malicious attacked node is identified and changed its status to inactive and it also increases the lifetime of the network.

***D*. Overview:**

*1)* The packet error rate in the existing (CLSS) and proposed (SCLSS) are approximately same, but after some time there is no packet error rate in existing algorithm CLSS.

*2)* Throughput is almost similar in the case of existing algorithm CLSS and proposed algorithm SCLSS, but in CLSS after a malicious attack on the network, for a certain period throughput is there and after a certain period of time the network is dead therefore there is no throughput.

3) Ater changing malicious sensor node to inactive state the Packet delivery ratio is accurate in the case of proposed algorithm SCLSS and there is no packet delivery ratio in the case of existing algorithm CLSS.

## VII CONCLUSION

In this paper, we have presented a SCLSS for integrated WSNs with MCC. A SCLSS scheme includes both the cloud and WSN. The integration of WSNs-MCC is the powerful technique and beneficial in the collection of data from WSNs & sharing with clients. Depending on the client's current location sensor node changes its status to active or inactive. When the energy of sensor node is below the threshold energy, we are changing its status to inactive to provide security for WSNs which are integrated with MCC. Simulation results show that WSNs which are integrated with MCC are secured and provides the maximum lifetime and increases the throughput and packet-delivery-ratio.

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