A Real Time Cloud Based Energy Efficient Mechanism for Radiation Affected WSN to Increase Network Life Time and Mobility

K.R. Asha, K. Suresh

Abstract: Due to the huge advancement of technology in wireless sensor network, WSN is used in large applications such as security, surveillance, health care, environment monitoring, and object tracking. In these kind of applications sensor nodes are detecting physical phenomena's like temperature, pressure, and humidity. Detected information's are finally forwarded to sink node or base station node. In this communication pattern, cooperation of each node in the network enable the hop by hop communication which reduces the energy consumption as well as time delay. Also due to some accidental events such as huge electro-magnetic waves and radiation will effects the sensors. This leads to the failure of certain nodes and that will affects all the nodes communication. Therefore, proposed mechanisms will tackle these kind of accidental events to avoid communication failure and also gives a technique for increasing energy efficiency of nodes to increase the lifetime of network. Data sensed by sensor will be collected, processed and sent through cluster heads to the base station in an efficient way. From the base stations collected data will be upload to cloud for user accessibility using cloud services. Simulation results show better performance concern to energy efficiency and the lifetime of the network.

Keywords: Acoustic communication, Cloud Computing, Data reduction, RF communication, Wireless sensor Network.

I. INTRODUCTION

An attack which uses the energy that will be radiated or transmitted in rays or waves pattern is identified as a radiological attack. Radiological attacks are initialized with the aim to affect the network communication. These kind of radiation attack will cause node outage problem which will be stopping the functionality of WSN's components. This node outage attack effects on the issues such as stopping the nodes' services, partial compromising of single or multiple node of WSN to stop them from its usual activities. Unattainability on receiving the collected information and creating loop holes for other type of attacks on the network. However to tackle these kind of accidental events communication failure mechanism are needed [3].

Wireless sensor network which is implemented with the functionality of collecting the data about its environment such as temperature, humidity, fire detection. These kind of functionalities are used in the applications such as habitat monitoring, forest fire detection, environment monitoring and etc. [2]. In these kind of application many sensor nodes are randomly deployed in the network area and each sensor node is responsible to collect the data from its covering area. Once data about the environment is collected, it has to forward to base station or sink node. From the base station collected data will be given to user's accessibility using cloud services

Usually WSN applications are placed in remote locations. WSN is fully implemented with sensor nodes which is having limited energy source [1]. If energy source of the sensor nodes are drained, data collection from those nodes are impossible. Replacement of the sensor node's energy source or continuous energy supply is not possible on remote location. So energy efficiency should be followed on each node to utilize available energy in efficient way to improve its lifetime which will reflect on life time of the entire network[4],[5],[6],[7],[8][9]. In WSN, data sensing, routing the collected data and securing the data over the transaction is energy consuming functionalities in each node. So energy efficiency should be achieved on these functionalities by applying an efficient techniques on these different process.

Applying energy efficiency on the data sensing is not an optimal way which will affect the coverage area. So it is aimed to apply the efficiency on routing and security. Whenever external attacks such as radiological attack is initialized on the network, it creates node outage problem. It will be difficult to collect the data itself. In these kind of attacks, hardware of the sensor nodes itself stopped from collecting the data or sending the data. Main characteristic of the sensor node is transfaulty, that is, it may sense its physical environment surrounding correctly, but fails to communicate with its neighbors when electromagnetic or nuclear radiation exposure has taken place, this leads to the temporary failure in communication [10], [11], and [12]. The presence of electro-magnetic or nuclear radiation is temporary. Hence, it is needed the sensor nodes behave normally with the resumption of favorable condition. In that situation complete removal of Node or Temporary Isolation of faulty nodes will not be an efficient solution.

In the proposed system, communication mode transfer mechanism is discussed to work in radiation-prone environments and continue communication between sensor nodes, a node has dual mode of communication. By using above said communication mode transfer mechanism, node outage problem will be solved in presence of radiation attacks and along with we propose an energy efficient technique on data routing process. Data routing process consists of two major phases such as route finding and transmission phase. In route finding process sender node have to identify the better route to reach destination node by using the control packets. Each node have to identify route and then have to transfer the collected data to base station, it will be huge work load on the nodes.

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If sensor nodes are working with huge work load it will reduce the energy quickly that will affect life time of that member node and also same cluster head in entire process is need to transfer data then also cluster head energy will be drained quickly. To overcome this issue we are proposing Stability factor based head election mechanism which will reduce work load on the sensor node by considering head rotation process. In addition to clustering mechanism we are proposing data reduction technique to reduce the amount of the data which will forwarded from cluster to base station for reliability based data transaction with data reduction filter.

By applying communication mode transfer mechanism, stability factor based head election mechanism, and data reduction technique is used to reduce the energy consumption which will improve the life time of the network

State of the art, above the topic is organized as follows: Section III discuss communication mode transfer mechanism algorithm for continue communication between sensor nodes in radiation prone environments. In section III Stability factor based head election mechanism reduce work load on the sensor node by considering head rotation process. In section V data reduction technique is discussed to reduce the amount of the data which will forwarded from cluster to base station to avoid the energy depletion. In Section VI gives simulation results of the proposed algorithm and result of uploaded data from base station to cloud of radiation affected WSN .finally in the section VII conclusion and future work is discussed.

II. LITERATURE WORK

Pushpendu Kar and Sudip Misra [3] dilver some facts related to effectively transfer the data by applying dual modes RF and acoustic in WSN. Establish the connectivity in network which occur due to temporarily lost connection between the nodes is and correct the sensed information to reduce information loss when radiation effect has taken but energy usage is more during network operation because of the receptions of control messages and increase in the number of transmissions. Hence feasible synchronous, simple, fast and efficient mechanisms are needed. H.R. Shea [11] realized that due to the effects of radiations, nodes sensing capability may be affected and which may lead to communication failure with the other nodes. Hence, in the presence of radiation, piezoelectric sensors continue to sense the environment because piezoelectric sensors are not affected radiations. But in case of other sensors, may sense erroneous data in the presence of radiations. Vladimirova et al. [13] recognized that jennic motes cannot work at 2.415 GHz of electromagnetic interference and also observed that radiation exposure is harmful to motes. Due to exposure it will found that poor transmission, connectivity failure and other functionalities. I. F. Akyildiz et al. [14] discussed that Acoustic mode communication plays a vital role in error-prone sensors, limited battery power, propagation delay limited bandwidth, impaired channel. Dini et al. [15] focused a method for establishing a link between a communication failure networks by using mobile sensor nodes. Information can be send from node in a partition to node in another partition or to base station through mobile sensor nodes by identifying proper position and consider the permanent node isolation problem but they can't be consider the communication failure due to temporary node isolation problem. Senel et al. [16] proposed a method to connect communication failure network by spider web based method using the minimum spanning tree algorithm and discussed about permanent node isolation issue but they are not discussed temporary node isolation occurring due to external environmental factors. Liansheng Tan and Mou Wu [17] proposed a workable data communication scheme utilizing the hierarchical Least-Mean-Square (HLMS) adaptive filter. This paper proposes a workable data communication scheme utilizing the hierarchical Least-Mean-Square (HLMS) adaptive filter. In this techniques predict the measured values both at the source and at the sink, nodes are subsequently required only to send those readings that deviate from the prediction. In this data reduction strategy data send from each node is reducing power savings. When failure of link between any two nodes occurs in a WSN, then sink will miss the actual reading and in that situation the prediction error exceeds the specified threshold that would cause the failure of the prediction approach. Cesare Alippi et al. [18] proposed an adaptive sampling algorithm for energy savings of both the sensor and the radio. That algorithm, for sensors estimates online optimal sampling frequencies. For that approach requires the design of adaptive measurement systems, minimizes the energy consumption of the sensors. However for the radio, while maintaining a very high accuracy of collected data and performs similar to a fixed-rate scheme where the sampling frequency is known in advance. This approach mainly depends on the power consumption of specific sensor is significantly larger than that of the radio. J.Praiseline Karunya and T.Aruna [19] proposed network configuration scheme with rotating cluster head based on adaptive cluster head rotation algorithm. In their method only remaining energy is used to elect the head node for the balanced energy consumption among the nodes within the cluster but it is not sufficient to increase the lifetime of network and also not reduces the energy consumption in the nodes of the cluster. Mao Ye et al. [20] authors evaluate and proposed an energy efficient clustering scheme for periodical data gathering applications in Wireless sensor network. In the cluster head election phase, a fixed number of candidate nodes will be selected and only residual energy will be consider for selection of cluster heads.

The existing works discussed in the literature reveal that the effects of radiations will causes failures in working of nodes, communication ,transmission. Hence feasible synchronous, simple, fast and efficient mechanisms are needed.

III. PROPOSED WORK

3.1. Communication mode transfer mechanism

In the proposed work communication mode transfer mechanism is discussed to work in radiation-prone environments and continue communication between sensor nodes, a node has dual mode of communication. The dual mode includes radio frequency (RF) communication mode and acoustic communication mode.

Usually a sensor node communicates using the RF communication mode. The RF communication gets affected due to the effects of radiations, which disables the sensor nodes from communicating. Therefore, in the presence of radiation effects the sensor nodes switch to the acoustic communication mode. Acoustic communication does not get affected by radiations. So, the sensor nodes continue their communication in the presence of radiations using the acoustic communication mode.

Algorithm 1: Radiation aware Communication mode adjusting

Input:
N : Set of sensor nodes in the WSN
RS (n) : Detection of radiation at the sensor node 'n'
CM (n) : Communication mode of the sensor node 'n'
RF : Radio frequency mode
AM : Acoustic mode
1: for each node 'n' in the network 'N'
2: Setting default communication mode as RF (RF mode)
3: CM (n) ← RF
4: Monitor radiation status at the communication range of the node
5: if radiation presents then changing mode in to acoustic mode
6: CM (n) ← AM

By using above said communication mode transfer mechanism, node outage problem will be solved in presence of radiation attacks. Next an energy efficient technique on data routing process is proposed, Data routing process consists of two major phases such as route finding phase and transmission phase. In route finding process sender node have to identify the better route to reach destination node by using the control packets. Each node have to identify route and then have to transfer the collected data to base station. Means, it will be huge work load on the nodes. If sensor nodes are working with huge work load, it will reduce the energy quickly which will affect life time of that node. To overcome this issue a clustering mechanism which will reduce work load on the sensor node has been proposed.

3.2. Stability factor based head election mechanism

In clustering process 'n' number of nodes are organized as a cluster. In the same way entire network will be partitioned as 'M' clusters. In each cluster, head selection algorithm will be applied to elect a node as head node. Instead of doing route finding and routing of data on each node, this tasks will be assigned to head node. Other than head node all nodes in the cluster will act as member node. Member nodes is only responsible for collecting the data and forwarding them to its head node only. Head node is responsible for collecting data from member nodes, data aggregation, and route finding to reach base station and forwarding the data on identified route. By doing these process at head node energy of the member nodes will be saved, but these process done by one cluster head continuously means its energy will be drained quickly. To avoid this, head rotation process will be initiated periodically. For certain time slot only one node will act as head, later another one efficient node will be elected as head to save previous head node energy. In previous clustering mechanism such as LEACH, only remaining energy is used to elect the head node [22]. But in the technique a Stability factor based head selection, the stability factor is calculated based on remaining energy, node coverage and mobility of the node.

The Remaining Energy is the amount of energy remaining in a wireless sensor node at the current instance of time (RE) is given by the equation (1)

$$RE = EG_{init} - EG_{cons}(t) \quad (1)$$

Where $EG_{init}(t)$ is the initial Energy of the node and EG_{cons} is the energy consumed by the node after the time period t and is given by the equation (2).

$$EG_{cons}(t) = (ND_{PT} * K1) + (ND_{PR} * K2) \quad (2)$$

Where NDPT is the Number of data packets transmitted, ND_{PR} is the Number of data packets received and K1 and K2 are Constants in the range (0, 1).

Node coverage ND(x) of the node is find out from ratio of average distance with its neighbors. It is given by the equation (3)

$$ND(c) = \sum_{1}^{N(c)} ((c,d) \in E / \ d \in N(c)) / \ |N(c)| \quad (3)$$

Where $|N(x)|$ gives number of neighbor's node, c and d is the node, E is the set of edges of a cluster of network Graph G (V, E).

Mobility Mob (n) of the node is find out by using the equation (4)

$$Mob\ (n) = 1/T \ \sum_{t=1} \sqrt{(x_t - x_{t-1})^2 + (y_t - y_{t-1})^2} \quad (4)$$

Where (x_t, y_t) and (x_{t-1}, y_{t-1}) are the coordinate positions of node V at time t and t-1.

The node which is having highest energy and highest node coverage and lowest mobility will get highest confide stability factor. Highest stability factor node will be elected as head node in each cluster. By applying this clustering mechanism we can obtain reasonable reduction of energy consumption on the data routing process.

Algorithm 2: Stability factor based head election scheme

Input:
N : Set of sensor nodes in the WSN
C : Set of cluster in the network N
B(c) : Boundary of the cluster
CH(c) : Cluster head of the cluster
M(c) : Member set of the cluster
X(n),Y(n) : Location co-ordinates of the sensor node
Pos(n) : Cluster position of the sensor node n
RE(n) : Remaining energy level of the sensor node n
Mob(n) : Mobility of the sensor node n
Con(n) : Concentration weight of the sensor node n
SF (n) : Stability Factor of the sensor node n
1: Clustering process
2: for each node n in the network N
3: Collecting the location co-ordinates X (n), Y (n)
4: for each cluster c in the network N
5: Collecting boundary details BX(c), BY(c)
6: if X (n) and Y (n) resides in B(c) then
7: Determine position of the node 'n' as c
8: Pos(n) ← c
9: Add node 'n' as member of cluster 'c'
10: M(c) ← c
11: End of for
12: End of for
13: Cluster head election process
14: for each cluster 'c' in the network N
15: Declare highest residual energy in cluster as zero
16: HRE (c) ← 0
17: Declare lowest mobility in the cluster as 1000
18: MM(c) ← 1000
19: Declare lowest distance with neighbor set in the cluster as 100
20: Nd(c) ← 100
21: Declare highest stability of the cluster as zero
22: HSF(c) ← 0
23: for each member 'm' of the cluster 'c'
24: Collecting remaining energy RE (m)
25: Computing mobility Mob (m)

26: Computing average distance Ad (m) with neighbor set with neighbor set
27: if (RE (m) > HRE(c)) then
28: HRE ← RE (m)
29: if (Mob (m) < MM(c)) then
30: MM(c) ← Mob (m)
31: if (ad (m) < Nd(c)) then
32: Nd(c) ←ad (m)
33: end for
34: for each member 'm' of the cluster 'c'
35: SF (m) ← 0
36 if (RE (m) ==HRE(c)) then
37: SF (m) ++
38: if (Mob (m) ==MM(c)) then
39: SF (m) ++
40: if (ad (m) ==Nd(c)) then
41: SF (m) ++
42: if (SF (m)>HSF(c)) then
43: end for
44: HSF(c) ←SF (m)
45: for each member 'm' of the cluster 'c'
46: if (SF (m) ==HSF(c)) then
47: CH(c) ← m
48: end for

3.3. Data reduction mechanism

In addition to clustering mechanism a Data reduction technique to reduce the amount of the data which will be moved from cluster to sink is proposed. Continuous transaction of the same data results in energy depletion. In our scheme data reduction technique monitors the collected data at each cluster level. Once data is collected and forwarded to head node by member node, then head node initiates the data reduction algorithm which will compares current data with previous round data collection. Difference between the current data and previous data will be identified. If the difference is greater than the data threshold value then it is to be consider has deviated members and threshold value to identify data deviation is taken has 10. Deviation ratio between the current data and previous data will be identified. Higher deviation ratio reveals that huge change in the environment which should be intimated to base station. Lower deviation on the data will be normal situation on the network. So this can be avoided from the transaction. Decision on the data transaction will be taken by head node based on the data deviation ratio and it is compared with member threshold value to decide for sending the data to data aggregation queue for that member threshold value has been taken as 50. Find energy aware route to reach base station to transmit the data to base station.

Average of the collected members in the cluster, avg (c) is find out by using (5)

$$avg(c) = \sum_{i=1}^{M(c)} data(i)/|M(c)| \quad (5)$$

Where | M(c) | is total number of members in a cluster and data (i) is the data of the i^{th} node in a member set of the cluster.

Deviation percentage, DP of the deviated members in the cluster c calculated by using (6)

$$DP = (DM(C)/|M(c)|) * 100 \quad (6)$$

Algorithm 3: Reliability based data Transaction with data reduction filter

Input :
N : set of sensor nodes in the WSN
C : set of cluster in the network N
CH(c) : cluster head of the cluster
M(c) : member set of the cluster
data[n] : collected data of the sensor node n
avg(c) :average of collected data in the cluster c
agdata[c] : aggregated data of the cluster head
Dm[c] : deviated members count of the cluster c
DT : Threshold to identify data deviation
DM(c) : deviated members count in the cluster c
MT : Threshold to decide on the data aggregation
DP : deviation percentage of the deviated members in the cluster c

1: for each cluster 'c' in the network N
2: for each member in cluster c
3: Collect data - data[m] at the sensor node 'm
4: Transmit the data to head node
5: m ⟹ CH(c)
6: data reduction phase
7: Computing average avg(c) of the collected data at head CH(c)
8: for each member 'm' in cluster c
9: difference[m] = avg(c)-data[m]
10: if(difference[m]>DT) then
11: DM(c) ++
12: Computing deviation percentage DP of members in cluster c
13: if(DP < MT)
12: avoid the data[m] from aggregation
13: else
14: add data[m] into aggregation queue
15: validating member threshold at cluster head
16: sending aggregate data agdata[c] from the aggregation queue
17: Find energy aware route to reach base station
18: Transmit the data to base station
19: CH(c) ⟹ BS
20: end for

IV. SIMULATION ANALYSIS

The proposed algorithm is tested on Network simulator (NS2) by distributing nodes in the environment of simulation. Parameters needed for our mechanisms are as shown on Table-1. The simulation of the proposed scheme has been checked for 50, 100,150 and 200 nodes deployed in the 3000×2500 simulation area. UDP communication protocol is used to give communication between the nodes and CBR traffic model is used to handle traffic in wireless sensor network. The propagation model two-ray ground is used to propagate radio waves and to receive the signal from all the nodes from all direction Omni directional antenna used. The proposed scheme is evaluated by considering reduction of energy consumption in efficient way to improve the life time of the entire ork network and efficiently and reliable transfer of sensed data.

Table 1: Parameters for Simulation

Type of Channel	Wireless channel
Time of simulation	50 ms
Media Access Control type	802.11
No of nodes	50,100,150,200
Traffic Model	CBR
Antenna Model	Omni Antenna
Simulation Area	3000x2500 m
Transmission range	250m
Network Interface Type	WirelessPH
Initial remaining energy	1.5J
Radiation affected area	1000-2000 X-axis, 750-1500 y-axis
Sensing range	30 m
Range of communication in Radio Frequency mode	90 m
Range of communication in acoustic mode	70 m
Radio frequency signal speed in air	$3*10^8$ m/s
Ultrasonic sound speed through air	330m/s

The proposed method gives reduction of energy consumption in nodes is very less compare to usual method that is, when kind of radiation attack will cause node outage problem which stopping the functionality of WSN's component. Figuare-3 shows comparison of usual method and proposed method in particular instant of time. Lot of energy is remaining in nodes of WSN improves the life time of the entire network and in energy efficient way.

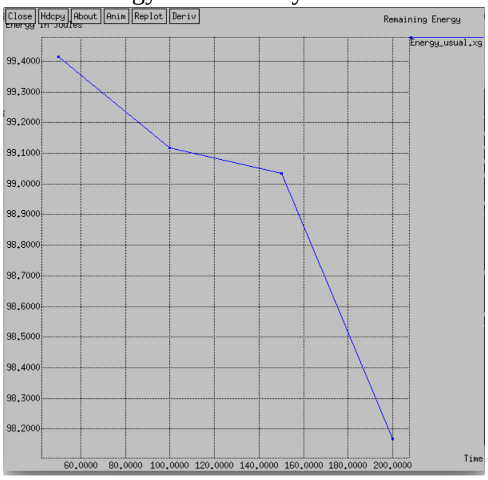

Fig. 1: Residual energy in usual method for 50,100,150 and 200 nodes.

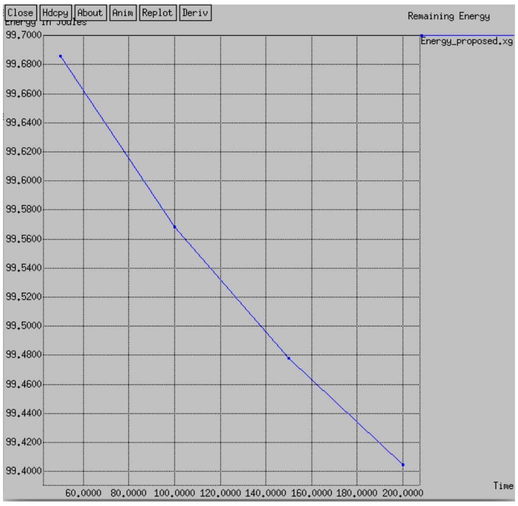

Fig. 2: Residual energy in proposed method for50, 100,150 and 200 nodes

The above Fig.1and Fig.2 shows how much energy is remaining in nodes during network operations by considering 50,100,150 and 200 nodes in radiation affected environment of wireless sensor network in usual method and our proposed method in particular instant of time.

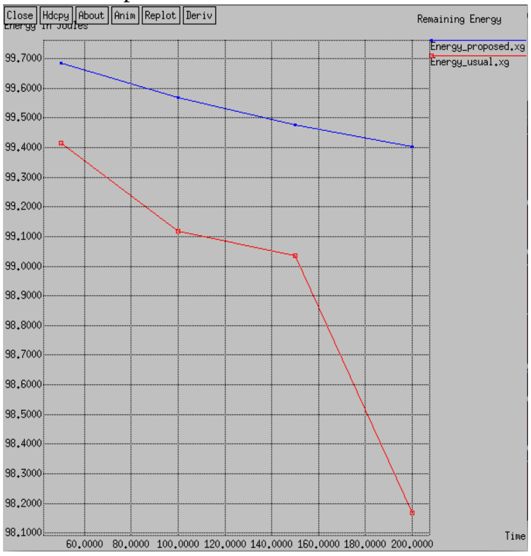

Fig. 3: Comparison of Residual energy for usual and proposed method of 50,100,150 and 200.

Fig. 3 shows comparison of usual method and proposed method in particular instant of time. Lot of energy is remaining in nodes of WSN improves the life time of the entire network and in energy efficient way.

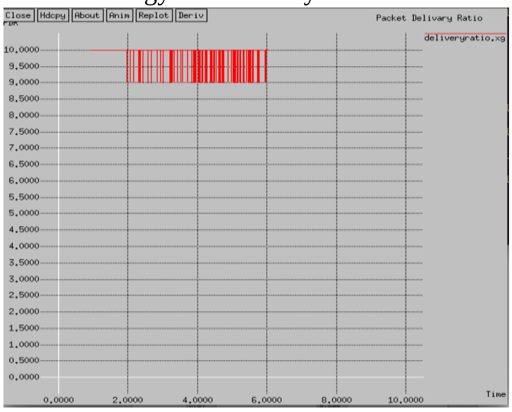

Fig. 4: Packet Delivery Ratio of nodes in Usual Method

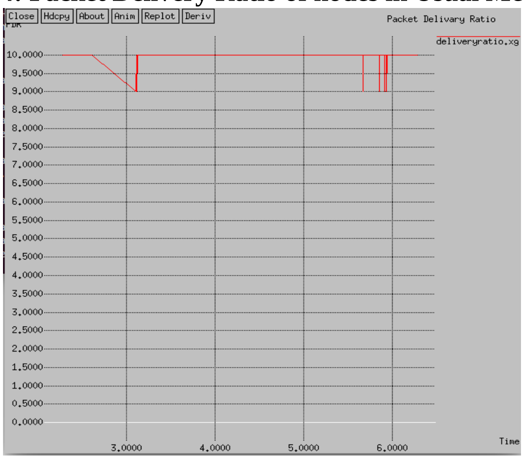

Fig.5: Packet Delivery Ratio of nodes in Proposed Method

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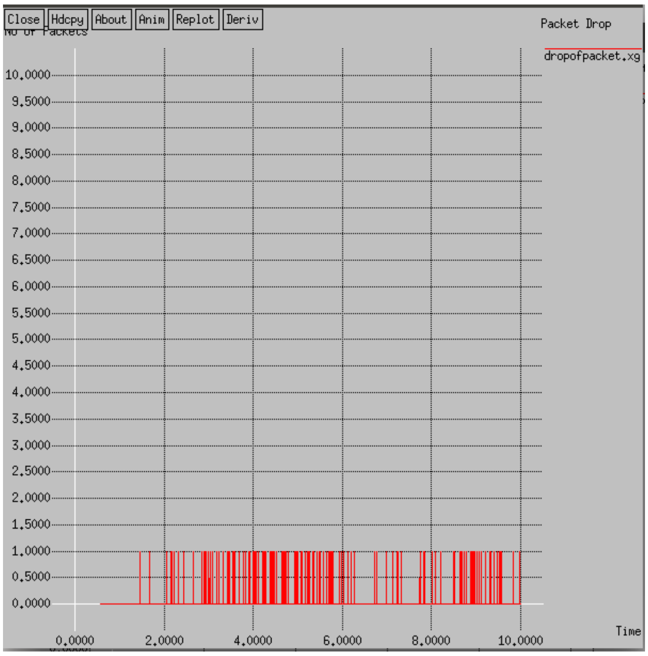

Fig. 6: Packet Drop of nodes in Usual Method

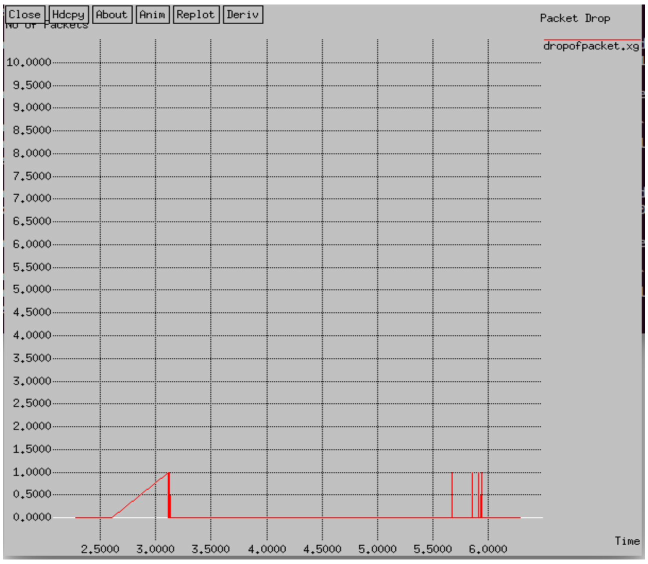

Fig. 7: Packet Drop of nodes in Proposed Method

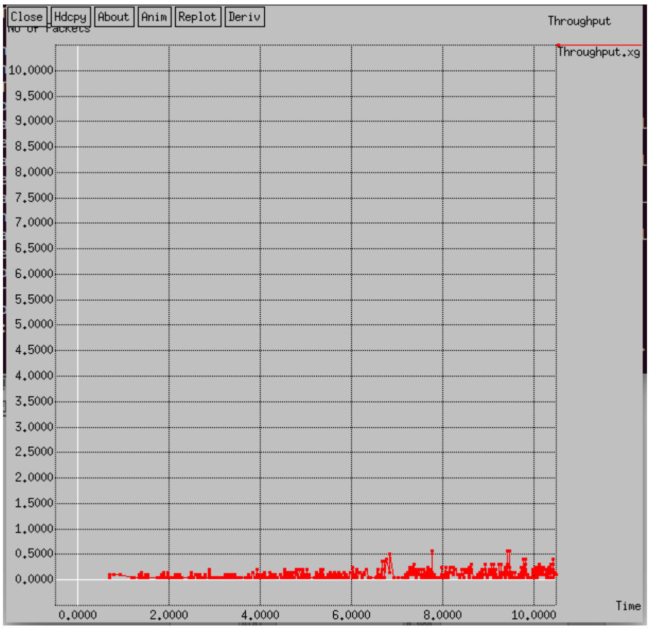

Fig. 8: Through put of nodes in usual Method

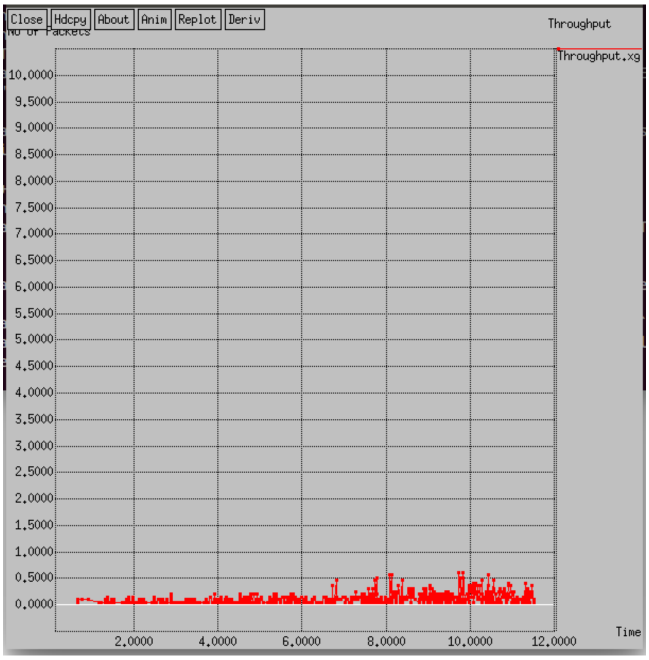

Fig. 9: Through put of nodes in Proposed Method

Figure-4 and Figure-5 shows Packet Delivery Ratio of nodes in Usual Method and Proposed method, Figure-6 and Figure-7 shows Packet drop of nodes in Usual Method and Proposed method, Figure-8 and Figure-9 shows Through put nodes in Usual Method and Proposed method respectively. In the proposed method sensed data can be reliably transfer to base station. It will be observed in the simulation results. From the base station data will be efficiently upload to cloud for user accessibility using cloud services.

By using the proposed approach, we were able to transmit data faster as compare to others and along with we give importance to energy constraint of sensor network in radiation affected environment and by uploading data from base station to cloud, we try to give information about in which place, at what time and how far from the base station the radiation affected area is there.

V. CONCLUSION

Advancement in the area of wireless sensor network and wireless communication technology, lots of research is going now a days to give better performance work in the field of critical situation environment. Sensor nodes in WSN available with limited power, which decreases the life time of network .To our approach will tackle these kind of accidental events to avoid the communication failure and also proposed a technique for increase energy efficiency of the nodes to increase the lifetime of network, in radiation affected environment. Data sensed by sensor is collected and processed by mechanism to reduce the amount of the data which will forwarded from cluster to base station , reasonable reduction of energy consumption on the data routing process will take place in an efficient way. Collected data and information about radiation affection in the environment from the base station will be upload to cloud for user's accessibility using cloud services.

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In future work, it has been planned to give security measurements with in the network and also in the cloud to ensure data confidentiality by protecting the data from intruders, data integrity by maintaining the accuracy and consistency of data in its complete network cycle and fine grained access control to the application.

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