An Innovative Approach to Prolong the Lifetime of WSN using Multiple Mobile Sinks Having Grid-based-Circular-Orbit

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***Abstract*—In Wireless Sensor Networks, nodes near the sink have to transmit data of those sensor nodes which are at a far distance from sink node. So they lose their energy very soon. Hence it divides the network and reduces the lifetime of the network as the sensor nodes die at an early stage. The resulting issue is called as Energy-hole problem. We overcome this problem by placing many mobile sinks which move in the network to gather the data sensed by other cluster heads which fall in its range. While collecting this data the mobile sink saves the information about the remaining energy of the sensor cluster heads. Using this information the mobile sink move to those cluster heads with greater energy. Hence the Energy-hole problem is reduced as the next neighbouring node of the sink is the greater energy potential node and sink keeps moving regularly. Thus there is a fair use of energy in the network which increases the durability of the network. To achieve this we prefer quite good geometrically principled Circular orbits consisting of many mobile sinks in the huge wireless sensor networks which have time based constraints.**

Suppose if we have 1000 sensor nodes and 40 sinks, then we can avoid 50% delay when compared to the mobile sinks with irregular pattern of movement. So placing mobile sinks in circular orbits of pre-defined range avoids energy loss or more usage of energy and is time efficient.

***Index Terms*—Wireless sensor network, energy efficiency, data gathering, circular orbit, mobile sink, trajectories, energy-hole.**

I.INTRODUCTION

A huge number of sensor nodes which are distributed strategically in some area to sense any physical activity is called as Wireless Sensor Network (WSN). Every typical wireless sensor network has the base station (BS) /sink near which many sensor nodes are present. The base station / sink has a connection with internet. The connection may be wired or wireless. The function of the sink is to instruct the sensor nodes and also to collect the data detected by sensor nodes. Generally base station will have unlimited energy & power supply. Based on required application, the sensor nodes detects the required physical activity and aggregates the data locally to prevent the unnecessary repeated data being communicated. Through hop-by-hop communication the sensed data is sent to the sink. As soon as the sink receives the data, processing of the data takes place. Then the processed data is transmitted to the internet which is easily available to the user. Any sensor node has many components like power-supply unit, sensing unit, memory-unit, processing unit (processor), transceivers and sometimes mobility modules, position modules and actuators. A late development in micro electro mechanical system (MEMS) has made the distribution of small size sensor network efficient both economically and technically. This has led to the development and improvement of wireless sensor network applications at cheaper rate. Now a days, there is increasing demand and usage of WSN in every walk of life. For example: managing disaster, military supervision, detecting forest fires, earth quake sensing wild life tracking, natural-calamity inspection, bio medical health application and many more. Unlike the classical wire-less network, the wireless sensor networks (WSN) comprises of specific unique design and resource limitations. Resource limitations may be limited sensing power, less memory space, low battery, limited range for communication. and less bandwidth. Irregular distribution, huge number of sensor nodes and remote environment are the design conditions. Based on the required applications the above conditions adds the difficulties in designing the wireless sensor network protocols. Since the batteries of the sensor nodes in WSN have limited power. Recharging or replacing those battery which are dead is a difficult task. We must make efficient use of battery power since it is the scarcely available resource in wireless sensor network. The main activities which consumes more battery power in sensor nodes are sensing, receiving sending and processing the data.In general the transmission of data consumes more energy and is costly when compared to processing the data according to the result of the related experiments. Roughly, energy used in transmission of 1-bit of data is same as energy consumed during processing of 1000 operations in the sensor node. Although the energy required to sense the data depends on type of the sensor, it is not much countable when compared to consuming the energy in transmitting and performing data operations. The protocols that are designed for WSN mainly focuses on effective usage of energy during communication and sensing of the data. Now a days, the development in the field of WSN is mainly based on energy efficient protocol. During the design of energy efficient protocol the main focus should be on gathering the data and routing in order to achieve highest efficiency. In general, the sensor nodes directly cannot transmit the data sensed to the base-station/sink since it has less power and limited communication range. Therefore,

the sensor nodes senses the data, as well as act like a router to transmit data to its neighbours. The data gathering protocols in wireless sensor network can be broadly classified in to 3 types namely Flat based routing, Hierarchical based routing and Position based routing. According to researchers the hierarchical based structure is said to be most efficient architecture for gathering data in wireless sensor network. The transmission of data from source sensor nodes to base station is a difficult task in wireless sensor network applications. The base station is static in wireless sensor network and all other nodes in the network transmit their data to the base-station through multi hop communication. Here the energy-hole problem arises which is nothing but depletion of the energy in the batteries of those sensor nodes near the base station. The energy-hole problem is defined as the process in which the sensor nodes that are nearer to the base-station would deplete their energy very soon since they are involved in transmitting the data of other farther nodes to the sink/base-station. Due to this the nodes that are far away from the base station/sink have good amount of energy but it cannot be used efficiently, since the nodes closer to the sink would have reduced their energy and therefore they cannot send their data to the sink across the energy-hole near the sink. This reduces the lifetime of the network. The main reason for the energy-hole problem is the static nature of the base-station, since every time the same nodes closer to the sink has to transmit the data .Now a days instead of static sink ,using the mobile sink method has gained people's interest and importance as it has increased the ability to improve the network performance like throughput and energy efficiency. Likewise, hierarchical based structure is said to be most efficient for gathering data in WSN when compared to other existing protocols. So now in this article we converge the 2 approaches and address the energy-hole problem in the clustered wireless sensor networks by implementing the mobile sink method. Here the MSRP(Mobile sink routing protocol) is used for increasing the lifetime of the network. In mobile sink routing protocol, the mobile sink moves in WSN cluster to gather the data sensed by the cluster heads within its range. At some instant the cluster heads present in the range of mobile sink transmit their data to the sink. The remaining sensor nodes would wait for the chance to become the neighbour of the mobile sink. Like this, while the sink is moving all other nodes transmit their data to the moving sink when the mobile sink comes closer to their vicinity. While collecting this data the mobile sink saves the information about the remaining energy of the sensor cluster heads. Using this information the mobile sink searches and moves to those cluster heads with greater energy. Now again the nodes within the vicinity of mobile sink transmit their data to sink via multi-hop or single-hop communication. Due to the movement of the sink, the nodes that are closer to the mobile sink change from time to time. Therefore no energy-hole is formed due to the mobility of the sink. The process of forwarding data is alternatively shared among the different greater energy clusters heads closer to the sink. This makes the fair use of wireless sensor network energy/potential and increases the durability of the network . Movement of sink near highest energy clusters avoids the mini hotspot at the place where mobile sink is present.Like this always the nodes with greater potential will be the neighbouring nodes of mobile sink and thus preventing the less energy nodes to become the neighbour of mobile sink nodes and reducing their potential which causes the energy-hole/hotspot. These are the techniques that can be made use of to achieve the balanced use of energy between the nodes which improve the lifetime of the network. The main contents included in the article are as below:-First and foremost thing is the use of MSRP(mobile sink routing protocol)for increasing the lifetime of the network in clustered wireless sensor network . Mobile sink routing protocol instead of using static sink architecture ,it makes use of dynamic mobile sink architecture and takes advantage of mobile sink for gathering the data. Therefore the energy-hole problem is avoided by oftenly changing the sensor nodes near the base-station. Nextly, the mobile sink moves in the networks based on the remaining energy information present in the cluster head. This makes the mobile base-station to stay near the nodes with greater potential while it is moving. Therefore only the nodes with greater potential would transmit the data of the nodes that are far from the sink. Hence, the energy from the nodes is used in a balanced way. Finally, by comparing the performance between the static sink and multiple sink, simulations are done to calculate the performance of the suggested MSRP protocol. The performance parameters are average energy for single packet and throughput.By making use of these algorithms we can prevent energy-hole problem and achieve balanced use of energy with the help of mobile sinks and thus prolong the lifetime of network.

The remaining contents of this article are:Part-II contains related work.Part-III contains MSRP(mobile sink routing protocol) for increasing the lifetime of the network .Part-IV has the results obtained from simulation.Part-V has conclusion of the article.

II. RELATED WORK

According to the network structure, routing is classified into 3 ways namely: flat based routing, hierarchical based(cluster based)routing and position based routing. The nodes have equal role with equal responsibility in flat based routing. All nodes work together to forward the data in the network.Based on the role of the node it is placed in the different degree of hierarchy in the network in the hierarchical based routing. The parameters to decide the role upon a node are position, topology, range of coverage and energy. The role of the nodes are not fixed it keeps changing based on the underlying scheme. Nodes know their position in advance and exchange the co-ordinates of their position with the neighbouring nodes in position based routing. During the route discovery for the transmission of data nodes make use of the position co-ordinates of their neighbouring nodes to calculate the distance to know which is the next hop.In general, collecting and forwarding data to static centre of control is done by multi-hop communication in WSN(wireless sensor

node). Since we are using multi-hop communication to forward a single packet to base station it includes many sensor nodes on its way to base station which depletes the energy of few nodes very soon and hence energy-hole is formed.The sensor nodes closer to base station should only take part in data relay instead of other nodes. This will lead to running out of the energy, which will finally result in network partition and limited lifetime of network. Accordingly, energy-hole is formed near base-station which has led to major problem of decreasing lifetime of wireless sensor network. Now a days, a fresh approach is made on using mobile base-station in wireless sensor networks. This approach includes moving of base station interior to the area of network which would roll up the data and decrease the cost. This approach has earned charm due to its applications. The event based user centric network application includes close intelligence application, remote observation, recovery based operations, detecting intrusions and other computing operation and applications. The increased potential of wireless sensor network applications and their ability in improving performance of network like efficiency of energy, throughput has bought the base-station mobility as a field of research interest.

In recent years, a large amount of approaches are suggested in base station mobility. We can divide these approaches into two form: proactive and reactive approaches. The mobile base stations collects the storage node which is pushed to it by the sensor nodes in the proactive approach. But in reactive approach, the roaming mobile base station pulls the reading from the sensor node while it is moving in the network. The below lines explains about few efforts of research in mobile base station.Using a single mobile element is not enough in larger networks, here we require multiple base stations. Accordingly, multiple base station controls mobile elements for collecting data. Moreover, balancing algorithm for load is used for distributing load among large number of mobile elements and each mobile element is serviced with the balanced amount of sensor nodes. Here we consider low powered wireless sensor network for increasing their lifetime in mobility base station. The sojourn time used to increase the lifetime of a network and determination of the movement of base station is done by formulation of linear programming. Since we aim at increasing the lifetime of a network, rather than decreasing the consumption of total energy used for communication of data, here different model is used when compared to previous solutions.We use data gathering applications for autonomous movement of mobile base stations. The period of data gathering can be segmented into 3 phases namely, base station movement, data collection and notification of base station positions. An autonomous strategy movement for the mobile base station was put up for balancing the consumption of energy of the sensor nodes and extension of network lifetime. The forwarding of data is done by higher energy node near the base station while mobile base station movement is towards the node which has greater remaining energy. While the sink is moving it does not pass near the lower energy nodes. The network lifetime is extended by making use of mobility of nodes, given by a survey of the protocols. The overview and comparison of protocol is given by making their division in 3 groups namely, mobile base station mechanism, mobile sensor redistribution mechanism and mobile relay mechanism. The balance in consumption of energy in the entire network in the protocols, with help of mobile base station is done by the virtue of smaller multi hop data delivery path. The group of sensors located near the base station must be supplemented from time to time change by the regular base station moment for balancing the energy. For improving the consumption of energy and lifetime of network, the protocols that use mobile sensor nodes must relocate nodes whenever they are with initial distribution. Relay is used by the mobile nodes to decrease the long distance communication and hence carry data to the base station. In addition to this, the mobile nodes also co-locates static sensors.

The stay-values like average energy of residual, the amount of neighbours in mobile base station is calculated by the metrics. The mobile base station having the higher stay value will be moved to new location. Hence we achieve balance in consumption of energy and decreases in draining of the energy near the base station. If there arises problem related to traffic management in wireless sensor network, then it is addressed by the mobile base station. Here explanation is also given on the effects base station mobility of the traffic load in wireless sensor network. Adaptive routing along with load calculation method are suggested to successfully adapt for sink-relocations. In order to provide base station relocation, we consider load of network and variations in path quality. In addition to this, two algorithms are used to provide optimization through joint congestion aware and relocation aware for reliability. For a single mobile base station network, we use distributed or deployed algorithm. Standard sub gradient and minimization in cost flow are the characteristics of the algorithm. The main aim here is to reach the higher life span of the sensor network. To provide different applications there are strategies present which includes collection of mobility pattern and collection of data. From experimental comparisons we can say that the applications which does not have time efficiency as a critical constraint, base station can move in the entire network area. The applications which requires to save energy and tolerate delays, this is best suited to those applications. The base station mobility becomes limited for the applications which does not have energy efficiency as critical. Hence fixed circular path/orbit along with data propagation of multi hop becomes the best approach..This gives delay in a very lesser amount.

Three protocols for gathering the data in wireless sensor network along with mobile base station is used. It also includes many mobile base station and combination of mobile and static base station. In addition to this, by equally spreading the base station in the network we can improve the performance of the distributed protocol. The protocol which works with the local information is usually present in randomization of protocol. MSSN includes the wireless sensor network along with the mobile base station. The conversion of communication from multi to single hop

gives energy to MSSN. For the purpose of management of retrieving the information and consuming minimum energy, we use transmission scheduling algorithm (TSA MSSN). The energy efficiency is undoubtedly said to be a core design problem and energy here is mainly consumed by the transceiver. Therefore, even now research is taking place in energy efficiency for gathering the data. Here for increasing the lifetime of clustered WSN we consider energy-hole problem and MSRP (mobile sink/base station routing protocol).

III. MSRP (Mobile-Sink-Routing-Protocol) for increasing lifetime of network.

Using multi hop communication, all the nodes transmit the data to the base station. This results in energy-hole problem which is nothing but depletion of the power in the battery of the node at the base station. Here considerable energy is left in the nodes that are away from the base-station in the energy-hole problem. But we cannot make use of the energy since they get drained at the base station. Gathering the data in wireless sensor network considers the energy efficiency as the core design in MSRP. The cluster based network has an entire sensor network being divided into smaller parts or region named as cluster. Every cluster has one node chosen as a cluster-head. The cluster head which is chosen is involved in collecting data sensed from other nodes, which are the cluster members that transmits the data to base station or next cluster head. The mobile base station moves around the network at the particular time the cluster head transmits the data to the base station. Until the mobile base-station reaches the neighbourhood, all the cluster-heads in the wireless sensor network waits for mobile base-station. This is how cluster head transmits the data to the mobile base-station, whenever the mobile base station is present in the neighborhood. Energy-hole will not be formed around the sink which is as the nodes in its neighbourhood keeps changing all the time. Therefore energy of the node in the network can be used in the balanced way. This increases the network lifetime. The following explains how data can be transmitted to the mobile base station in clustered wireless sensor network. Gathering of data in mobile base station is divided in to 2 stages namely, setup stage and steady stage. The following gives the outline of key functions of these stages:

1)Setup-stage: In this phase mobile base station sense single message in the area of sensor nodes. The registration message is sent by sensor nodes after they receive the signal message. The setup stage is further classified into 3 sub stages namely initialization, mobile base station promotion and cluster head declaration.

Initialization: Initially clustering is done then the data is sent from node to the cluster head. After transmission of data they wait for mobile base station to come to the area where the data was sensed.

a) Mobile base-station promotion: After reaching new target mobile base station broadcasts active message. The signal message comprises of the information about the position of mobile base station. When the cluster head gets the information about its existence it send the data.

b) Cluster-head declaration: Here the cluster head accepts the active message of the mobile base station and responds by transmitting registration message to mobile base station.

2)Steady-stage:The genuine work of mobile-sink is gathering of data while it is moved in the network. Steady stage can be further be classified in to 3 stages. They are:

a) Scheduling of TDMA: To the declared cluster head the mobile base station send the TDMA schedule.

b) Delivering to sink: Every cluster head uses single-hop or multi-hop communication to transmit the sensed data to the base station. Here only detected data from any activity is sent to base station.

c) Movement of sink: The decision for moving to next position is taken by mobile base station. The initial movement cycle in the mobile base station is based on position which is predefined. The further cycle are told by remaining energy of the node present in the network. This ensures balanced movement of energy. The mobile base station is moved to greater energy cluster head.

A).Setup-stage: Initialization: Initially network is splitted into clusters then the data is sent from node to the cluster head. After transmission of data cluster-head wait for mobile-sink to come closer so that it can easily deliver its data.

B).Setup-stage: Mobile-sink promotion

After reaching new position mobile base station broadcasts active message. The active message comprises of the information about the location of mobile base station. When the cluster head gets the information about its existence it sends the data. The information here is moved at velocity V.

Procedure I: Mobile-sink promotion

Let t_i be the time-peroid wrt delay in communication. CH1 be cluster-head declaration.

CH2 be cluster-head acknowledgement.

Mobile-sink delivers the active datagram and initializes the time-interval t_i according to the delay in communication.

IF mobile-sink gets the datagram from other sensing nodes in the time-interval t_i

IF the received datagram is
CH1 Deliver the acknowledgement
that node
Place that node in recorded CH-list

END IF

ELSE

Decide upon the further movement of sink.

ENDIF.

C).Setup stage:Cluster-head declaration: The mobile base station node registers the distribution range of cluster-head node. The cluster head node perceives active message of mobile-sink. If the cluster head has not sent the data to the base station then it gets to know that mobile base station is in communication range and can send data. The cluster-head node checks the contrasting address information present in the message with the address of its own. This is done on receiving a token of active message from the mobile base-station. Then it is checked whether cluster head has sent data to the base station during its earlier movements of the present cycle. In case it is true then promotion message is ignored else declaration request is sent in response to mobile base station (CH1 register). Then the cluster head waits until CH2ack is received from mobile base station. This time interval is called communication delay.

D).Steady stage: Scheduling of TDMA

Initially the cluster head is registered in its current neighbourhood then the mobile base station allocates time intervals to all the declared cluster head. When the slots are registered the cluster head node can send the detected data to the mobile base station. Accordingly, the base station sends the TDMA schedule to the declared cluster-head. The following algorithm explains the TDMA scheduling: Procedure

2: Method for TDMA scheduling

1) Verify the cluster-head recorded in preceding stage and appropriately set the time-interval for the cluster-head recorded.

2) Now the mobile-sink delivers the TDMA schedule for recorded cluster-heads.

3) Mobile-sink waits untill the data is perceived by the cluster-head and accepts the perceived data from the cluster-head.

4) Simulcasts the information regarding time-interval for coming rounds.

E).Steady-phase: Delivering to sink

This details how the cluster heads should deliver the detected data to their mobile sink within the assigned time interval. During the predefined TDMA time-slot the cluster head delivers the data sensed to mobile sink via single-hop or multi-hop communication. Along with the data sensed, the cluster head also piggy-backs the remaining energy information to the mobile sink. At the base station, the information regarding the remaining energy maintained in CHRET(cluster-head-residual-energy table). This information is later used in deciding the sink movement for the fore-coming phase.

F).Movement of the sink

In the first cycle, the decision taken is to move the mobile sink to the predefined position in networks. During the second cycle and the further cycles, mobile sink scan through the network to move towards the cluster heads with greater potential. During the collection of data perceived from the previous phase, the mobile sink knows the remaining energy information. At the end of each cycle, the sink node checks the remaining energy of the cluster heads to decide about the next position where it needs to stay by giving more importance to the highest remaining energy. This ensures that the immediate neighbours of the mobile sink are always greater potential nodes, since they forward data of nodes that are far from the sink/base-station. This prevents the formation of energy-hole near the sink,since the neighbouring nodes of the mobile sink changes from time to time. Hence, the durability of the network increases. The following algorithm states the sink-mobility algorithm:

Sink-mobility algorithm

1. Verify the data sensed from all cluster heads that are obtained within the allocated time interval.

2. IF first-cycle

   Migrate to next pre-defined position and deliver the active data information once reached there.

   ELSE

   Search the CHRET(cluster-head-residual-energy table)

   Obtain the position of cluster head with greater potential.

   Move to the position of cluster-head(greater potential).

   ENDIF

G).GEOMETRIC-SINK CIRCULAR ORBIT

The geometric shape of the sensor network area is assumed to be a circle. May be the huge number of sensor nodes are less uniformly distributed in the large scale cluster of WSN(wireless sensor network). During the formation of these circular orbit all the sensor nodes of the network may not be present inside the range of this circular orbit. The best position to place the multiple mobile-sinks in the circular orbit is quite difficult to find out which causes a graphical problem called as optimal sink trajectory(OST). The solution to the problem is given by tiniest circle enclosing the nodes as shown in fig 1. The best position to place the sink is at the center of the circle in order to reduce the distance between the sensor nodes and the sink-node. The steps involved to construct the geometric sink circular orbited path are:

1. We allocate similar sized areas to the sink in order to increase the life time. There are various ways to do this.
2. The best position for the placement of the sink is calculated so as to reduce the delay.
3. At the end to move the sink node to the next position we determine the circular path for every sink.

The 14 sink network is equally sectorized as shown in fig 2(a). It is enough to find a tiniest enclosing circle for any of the circular sectors since the sectorization is symmetric in nature. The advantages of the equal sectorization are simplicity, congruity and scalability. Even though more sink nodes are available it does not improve the delay performance after it reaches certain number of sinks. To reduce the maximum distance among growing number of K sinks we prefer another method of partitioning the sectors of the sensor network. This is done by having two concentric-circles with radii r and R as shown in the fig 2(b). To obtain a balanced area allocation, we split the circle into 2 parts such that we reduce the maximum distance between the sink and any point in the circle. This kind of splitting of the network is known as polar-grid.

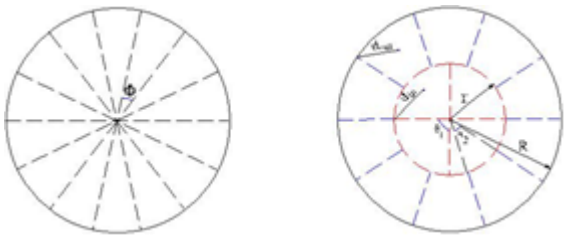

Fig. 2. (a) equallysectorized sink allocation and (b) a polar-grid sink allocation.

The sink trajectories are shown in fig 3(a),(b),(c). initially fig.3(a) shows a random walk for each selected sink which is placed randomly. It is a simple method that acts as a reference point in determining how far putting greater effort is justified in planning the circular path of sink. The fig.3(b) shows how multiple sinks circulate in outer boundary with equal distances from each other in the WSN. Fig 3(c) shows polar-grid with equal sectorized circular path which shows the inner circle considered as the inner boundary for the movement of the multiple sinks.

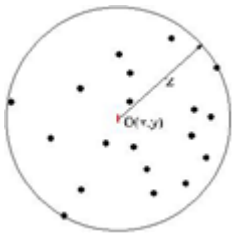

Fig.1. A illustration of tiniest enclosed circular orbit

Fig. 3. Competitor: (a) a random-walk, (b) an outer-boundary, and (c) an equallysectorized circular orbit

IV. SMULATION AND RESULTS

Simulations are used to calculate the performance of MSRP and that performance is compared with multiple sink strategies and static sink strategies. OMNet 4.0 is used for simulation. The details of the simulation setup and collected results are shown below:

Simulation setup: Simulations are carried out within the area of sensing which is of the size 200sq.m and the sensor nodes vary from 10 to 240. Based on the uniform distribution the random deployment of the sensor nodes are chosen by(X, Y) positions.

Obtained results: The performance is compared with multiple link strategies and static sink strategies of MSRP. For comparing the performance the parameters are average energy for single packet and throughput.

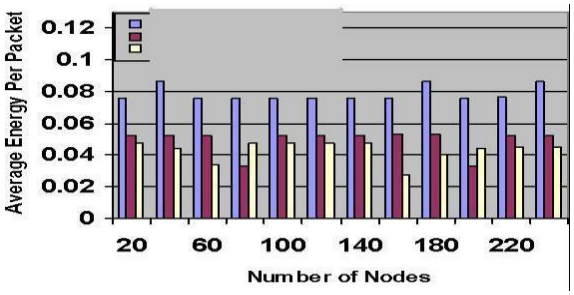

Fig.4: Average Energy for one Packet v/s various number of sensing nodes.

The above graph indicates the lifetime optimization obtained by the protocol. Average energy for a single packet is measured across changing number of sensor nodes(10-240)in this experiment. Here the average energy consumed for a single packet is less than static-sink and multiple-sink. The main reason for this is that in the static-sink and multiple-sink methods, the nodes near the sink remains in same place. So they are affected by energy-hole problem.This problem is more worse in static-sink since entire data is relayed to the same sink via same node that is closer to the sink. Even though this problem is present in multiple-sink, it is not so much worse when compared to static–sink. Contrarily, by the use of dynamic mobile-sinks the energy-hole problem is reduced in the suggested algorithm. Since the nodes are closer to the sink are greater potential nodes and vary from time to time. Therefore the suggested protocol increases the lifetime of the WSN compared to static-sink and multiple-sink.

Throughput (number of packets for one second):

At the base station the amount of packets received in one second is called throughput.In this demonstration by varying the amount of sensor from 20-220 the throughput is measured in form of packets per second. Fig.5 tells about the simulation results obtained from 3 compared protocols. In terms of throughput the proposed protocol exceeds the static base station and multiple base station approach. The main reason for this is that the nodes closer the base station remains same. Hence they are exposed to energy-hole problem. Therefore the data cannot be transmitted to the static or multiple base station when energy-hole occurs in the network. This problem becomes worse in static base station because the data is transmitted in same base station but in multiple base station the problem is reduced, still it is present. Multi-hop communication cannot be done because of formation of energy-hole across this region. This limits the amount of packets to be successfully sent to the base station per second. In the proposed protocol energy-hole problem is tackled using moving sinks. The energy-hole problem can be reduced by immediately changing the neighbour of base station due to regular movement of sink. Therefore more packets can be transmitted to the base station. Hence this proposed protocol has greater throughput when compared to static or multiple base-station approaches. Additionally we can observe from fig.5 the proposed protocol is more flexible and has better characteristics when compared to other protocols.

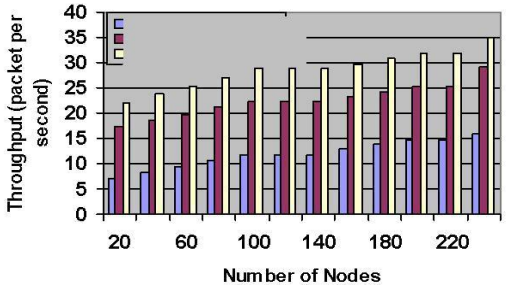

Fig.5: Throughput (packet for 1 second) v/s various number of sensing nodes.

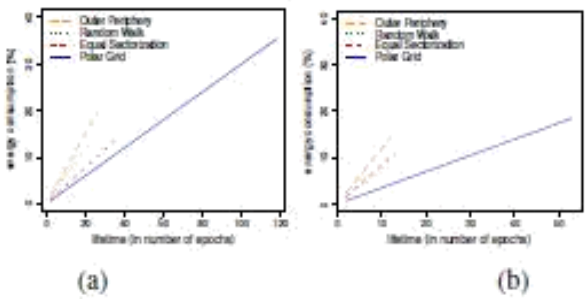

Figure 6: Throughput (packet for 1 second) v/s various number of sensing nodes

CONCLUSION

We refer to the energy-hole problem and suggest MSRP(mobile-sink based routing protocol) for prolonging network lifetime in clustered WSN in this article. Simulations are carried out to calculate the performance of suggested strategy using OMNet4.0. performance of the suggested strategy is compared to the static-sink and multiple-sink strategy, using the metrics such as energy consumed per single packet n throughput. The final results obtained after simulation determine that mobile-sink strategy along with grid based circular Orbit is more

efficient than both static-sink and multiple-sink strategies in the parameters like energy for single packet and throughput.

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