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Performance Analysis of Mobile Wireless Sensor Network with Energy Efficient and Reliable Routing

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ABSTRACT

In this paper author describing the concept of throughput and limited energy consumption while routing data to base station and will use multiple routes to forward data to base station. Wireless sensor networks (WSNs)remains resource constrict. Energy is one of the most essential resources in such networks. Hence, optimal use of energy is significant. In existing scheme sensor nodes are movable, base station is fixed and energy consumption is more. To overcome this, we are using the E2R2 protocol in which both sensor nodes & base station are mobile. The proposed protocol is hierarchical along with cluster based. All clusters contain one cluster head (CH) node, dual deputy CH nodes, also a few of ordinary sensor nodes. The reclustering time along with energy requirement has been decreases by introducing the concept of CH panel. All things Considered the reliability aspect of this protocol, it brings leading effort to provide a detailed throughput level by the BS. Topology of mobile wireless sensor networks with more no of nodes which is formed as clusters and transmission of packets between the sensor nodes is done to the base station [BS].Which is routed using E2R2 PROTOCOL, parameters such as throughput, energy spent. The simulation displays a certain proposed design successfully decreases the energy consumption among the nodes, and thus significantly improves the throughput compared to the existing protocol.

Keywords : Mobile Nodes, Energy Efficient, Mobile Base Station, Routing Protocol, Reliability, Wireless Sensor Networks (WSN).

I. INTRODUCTION

Wireless sensor networks (WSN) is widely used for gathering data in the distributed fashion Wireless sensor networks are extremely energy constrained within the terms of resource, also the topology of corresponding networks remains very dynamic. Sensor nodes are strictly energy constrained and entire the tasks like sensing, data processing, communication as well as both transmission and reception about signals etc, are to be broadcast over utilizing the usable limited energy. After the successful and efficient deployment as well as process of the wireless sensor network, there are many protocols and several algorithms are to be application specific. These sensor nodes transmit sensory data towards the resourceful base station (BS). Wireless sensor networks have large range of applications in civil and military domains. Several application areas of WSN are as follows: Battlefields, monitoring and alarming systems for supermarkets, intrusion detection, hostile zones, wildlife monitoring systems and disaster affected area and various safety and security related applications. The sensed data are eventually forwarded toward the BS for more processing and decision making with consider to the control for meeting the objectives of the system in place. Depending upon the application

type, the sensor nodes and the BS can be static or mobile. Reliable and successful data delivery at the BS is desired. Energy efficiency is an important aspect of any application of WSN. In multi-hop communication, the major issue may be the selection of the intermediate nodes in the route. The intermediate nodes are to be selected in such a way that the energy requirement is minimized. At the same time, the data are to be delivered at the BS reliably and successfully.

In the hierarchical routing, certain higher-energy nodes can be used to process and send the information to the base station when lower energy nodes can operate the sensing in the target domain. The total network is broken into layers. Hierarchical routing is studied to be energy efficient as well as scalable approach and there are various hierarchical routing protocols proposed for WSN. All the following protocols consider the WSN with static sensor nodes. These protocols are not suitable to manage mobility of the sensor nodes and the BS. Although Ad-hoc on demand distance vector (AODV) routing, destination-sequenced distance vector (DSDV) routing, dynamic source routing (DSR), temporally ordered routing algorithm (TORA), and zone routing protocol are some routing protocols that exist for mobile ad hoc networks, these are not well suited for WSN setup. This is so, due to different features of WSN and the unique constraints WSN suffers from. Moreover, the WSN applications have different sets of requirements. Routing in a WSN setup in which both the sensor nodes and the BS are mobile is a challenging problem.

Existing protocol do not study the mobility in both base station (BS) and sensor nodes. These are not well suitable for the mobile WSN. The communication links may regard of the connectivity issue and also in such a WSN setup. Data packets are to be routed fetching this connectivity issue into consideration. On the other hand, there will be significant loss of data packets due to failed links away from all other reasons corresponding to the frequent death of sensor nodes or else noise of the wireless links.

Here we are proposing the mobile wireless sensor network for energy efficient and reliable routing. This is a hierarchical one. The main objective is to attain energy efficient and to produce connectivity to the nodes. The mobility of the nodes are designed when routing decision are made.

II. Existing System-Modified Low Energy Adaptive Clustering Hierarchical protocol (M-Leach).

Modified Leach protocol (M-LEACH) is extended version of LEACH. Before to study M-Leach let us know about the LEACH Protocol In Leach protocol every CH sends the total data to the BS directly. Low Energy Adaptive Clustering Hierarchy (LEACH) protocol uses hierarchical network topology using which the data is combined and the same is sent to the BS. This is self-adaptive and self-organized. The nodes are divided into clusters or groups with uniform size, and a CH is selected for every cluster. The nodes accumulate physical occurrences related data and send the same to their respective CHs accepting TDMA schedule. If a node continues to last as a CH, its energy is drained and the node dies sooner. In order to avoid such a situation, the CH role is rotated after each round of operation. A node forwards the data to its CH and the CH gathers the data from each node supported by it and the CH computes the aggregate of the collected data and the same is forwarded to the BS.

LEACH considers homogeneous nodes in a network with respect to energy which is not realistic approach. In particular round, uneven nodes are attached to

multiple CHs. In this case, CH with large number of member nodes drains their energy as compared to CH with small number of associated member nodes. Furthermore, mobility support is another issue with LEACH routing protocol.to overcome this problem here we are going with M-LEACH Protocol.

To avoid such a situation, using multi-hop LEACH (M-LEACH),a CH can create use of one of its neighboring CH nodes towards the BS can carry node to forward its aggregated data. In the corresponding manner, a multi-hop communication path could be established so as to forward the data of a distant CH. All the relay nodes involved are CHs themselves; M-LEACH protocol is approximately the same as LEACH protocol, only it will form communication mode from single hop to multi-hop between cluster heads and base station. Its multi-hop routing algorithm within one round is shown in figure. Routing of multi-hop-LEACH protocol

In cluster formation, initially each node selects their CH based on residual energy and distance from the BS. The routing mechanism process is divided into two different phases:

- Route discovery and
- Distance calculation.

In route discovery, the source node checks its route cache before sending the data to the destination node; if there is no path in the route cache then it will accomplish a source route to the destination using this routing mechanism. To discover the route from source to the BS and other nodes,

The distance D is calculated using the formula Where, (a1, b1) are the coordinates of the source node and (a2, b2) are the coordinates of the node from which the distance is calculated.

$$D = \sqrt{(a2 - a1)^2} \quad + \sqrt{(b2 - b1)^2}$$

The node with residual energy greater than the threshold value is considered the relay node for multi-hop communication. Route maintenance detects broken links along the source node to the destination node. The damaged routes are maintained by substituting some new paths in the existing route. CH selection is based on mobility of nodes. A node with minimum mobility and lowest attenuation power is selected as CH in M-LEACH. Then selected CHs broadcast their status to all nodes in transmission range.

Member nodes compute their willingness from multiple CHs and select the CH with maximum residual energy.

Algorithm(shortest path distance based clustering algorithm)

1. Assigning initial energy to all the nodes.
2. Choose BS, CH, and DCH on the energy basis.
3. Arrange BS, CH and DCH in the hierarchy form as stated in the protocol.
4. BS and all other nodes participate in communication to receive and transmit the data packets
5. During the communication, if any CH node lost the energy concerned DCH will be placed at CH and CH will be moved to DCH place, and perform usual communication.
6. We consider the CH and DCH and all other sensor nodes have mobility in network.
7. The protocol ensures reliability in terms of data delivery at the BS it is achieved through use of multiple routes and switching of the route as decided by BS.
8. We adopt *mathematical* based **'Distance formula'**

$$D = \sqrt{(a2 - a1)^2} \quad + \sqrt{(b2 - b1)^2}$$

That can be used for identifying the most suitable path for data forwarding

9. Send data packets to the reliable path through multiple hops.

In modified Leach protocol for BS is fixed and sensor nodes are mobile. By using this M-Leach protocol BS is static. Sensor nodes are sending data to the BS directly it will consume more amounts of data. Then energy will be loss and live span of the nodes will die soon. Depending upon the situation we are introducing the Energy efficient and reliable routing for mobile wireless sensor networks (E2R2) protocol.

Drawbacks:-

- In existing system BS is fixed.so energy consumption will be more because of far neighborhood node.
- As the size of the network grows various performance metrics begin decreasing.
- Low throughput
- High energy consumption

III. Implemented protocol (E2R2)

The implemented protocol is a wireless network in which both the base station (BS) and the sensor nodes are mobile. The implemented protocol, which is called E2R2 protocol, achieves fault tolerance by contributing some alternate routes to forward data in the presence of any fault in the actual route. The main theme of the project is to extend the lifetime of the sensor nodes in the network. The protocol provides some appropriate alternate routes for packet deliver in presence of node or link failure in the present route. This arrangement does not provide the throughput level at the BS, in terms of packet delivery, to degrade drastically. The protocol attends the energy efficiency and the reliability of the routes. The data packets are routed throughout multiple hops in order to reduce the transmission energy demands at the sender nodes. In addition, some sensor nodes are intelligently arranged for dormant state, whatever is a low-power state. Those nodes are arranged for dormant state, whose services are not required at a particular time. Later stage, these nodes may operate state transition and get active while needed. The state transition is decided by the BS. This saves substantial amount of energy at the nodes. Hence, the battery lives of the sensor nodes become prolonged.

Architecture of wireless sensor network

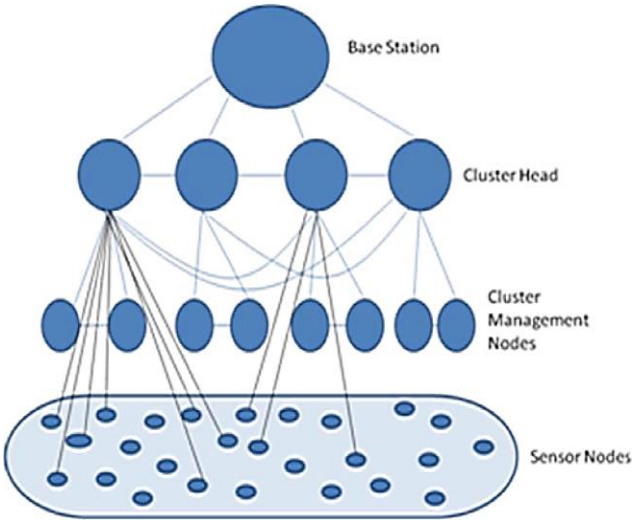


Fig 1.

After the arrangement of the sensor nodes, the BS creates groups of dissimilar sensor nodes in order to arrange clusters. Each cluster contains a CH node and two DCH nodes. The BS selects a set of suitable sensor nodes from each cluster, which can act as CH or DCH at a later stage. This set of nodes is also called CH panel. The cluster members i.e.; the sensor nodes, forward data to the respective CH node. The CH nodes do the data aggregation to remove redundancy and then forward the aggregated data toward the BS. The DCH nodes do several cluster management tasks that include mobility monitoring also. Other cluster management tasks are, for example, collecting location information of cluster members regularly and communicating this location information to the BS. They also remain ready to act as intermediate hop in presence of faults in some CH nodes. Therefore,

the DCH nodes are also called cluster management nodes. The CH nodes do not transmit data directly to the BS, unless it is the nearest one to the BS.

The communication pattern or the route for the CH nodes is determined by the BS and distributed to the respective CH nodes. It is assumed that the BS has an idea about the expected number of data packets (i.e., the volume of data) to be arrived in it during a specified time interval. Therefore, the BS keeps on monitoring the actual volume of data arrived from different clusters in the network. If the BS observes less arrival of data packets from some clusters in comparison with a prespecified threshold level, then it informs the respective CH nodes to check their connectivity with their cluster members. The CH considers this as feedback from the BS and accordingly checks the current connectivity with its cluster members. If the connectivity status of the cluster members with the respective CH is very poor, the BS decides to shift the charge of cluster headship to another suitable member from within the CH panel. Depending on the connectivity scenario, the cluster headship may be transferred to one of the two DCH nodes also. The routing decisions are made at the BS and then communicated to the sensor nodes. Since the sensor nodes are resource constrained and, moreover, the nodes are also committed to data processing and communication apart from sensing activities, it is always advantageous to offload the routing decision making process from the sensor nodes. Therefore, this protocol exploits the resourcefulness of the BS by shifting routing and some cluster management activities to the BS.

Self –organization phase

After random arrangement of sensor nodes in the sensor field. In this phase clusters are formed. The present CH and two DCH nodes are preferred by the BS. At first, the BS collects the present location information map. Sensor nodes can sense the geographic location information through some GPS-free solutions. Based on the velocity of a sensor node, the BS can prepare a rough estimate of the zone in which the sensor node is going to be in the next time interval. The next time interval is a specific time period for which a particular setup of the network remains valid. The value of the next time interval can be set manually depending on the type of the application, and this value is critical because most of the computations, e.g., cluster setup validity period and medium access slot, are dependent on the next time interval.

At the initial stage of the self-organization phase, each node should be satisfies three parameters.

- Geographic location information
- Residual energy level
- Mobility level or average speed of the nodes

The CH node can be elected based on these parameters in which it is having more residual energy then it will be elected as CH & DCH nodes. Here clustering can be formed **"K-means clustering algorithm" Implemented Algorithm (K-Means clustering):**

Let X={x1,x2,x3,……, x_n} be the set of data points and V={v1,v2,……, v_c} be the set of centers.

Step 1: Randomly selects 'c' cluster centers.

Step2: Calculate the distance between each data points and cluster centers.

Step 3: Assign the data point to the cluster center whose distance from the cluster center is minimum of all the cluster centers.

Step 4: Recalculate the new cluster center using:

$$v_{i=(1/c_i)} \sum_{j=1}^{c_j} x_i$$

Where 'C_j' represents the number of data points in the i_{th} cluster

Step 5: Recalculate the distance between each data point and new obtained cluster.

Step 6: If no data point was reassigned then stop, otherwise repeat from step (3).

Here in this implemented protocol we are using two protocols. The one is shortest path clustering algorithm and anther one is K-means algorithm. Here, K- means no of clusters.

IV. NETWORK OPERATIONS

In this section, we illustrate the network procedures utilized in E2R2 protocol.

Function of sensor nodes:

The sensor nodes are randomly deployed in the field, with some dimension. Sensor nodes sends data to the cluster Head (CH).Sensor node moves random direction with a random value of speed.

Clustering:

It is a bunch of nodes in a network that are grouped together to reduce energy consumption in data transmission.

Role of CH:

The CH node is responsible for gathering sensed data from the cluster members, aggregate those and forward toward the BS either directly or in a multi-hop fashion.

Role of DCH:

The DCH nodes keep monitoring the sensor nodes' mobility pattern. DCH nodes are also called "**cluster management nodes.**

The reason behind selecting two DCH nodes is the necessity to maintain connectivity between the clusters.

Role of BS:

It is an information processing center where a high energy node processes all its data that are sensed by the sensors in the network. Base station also handles sensor network routing or node configuration.

DCH-BS Network Creation: Similar to the CH-BS network creation process, the BS also creates the DCH-BS networks. In this situation, only the DCH nodes in the sensor field are considered. Alternate routes are also created for the DCH and switched intelligently by the BS.

Current Cluster Setup Cycle Length: An important and critical issue is how long a particular cluster setup will remain valid. Depending on the initial energy level of the sensor nodes and the kind of application, the optimal time duration is fixed. This optimal time duration is called as cycle length, and the current cluster setup remains valid until the end of the cycle length. However, exception may always occur. For example, due to mobility of the nodes, severe link failures may occur, and nodes may die out due to depletion of energy, which may together cause network partition. In such situations, current cluster validity time, i.e., cycle length, may become outdated, and reclustering may get initiated by the BS before expiry of the cycle length.

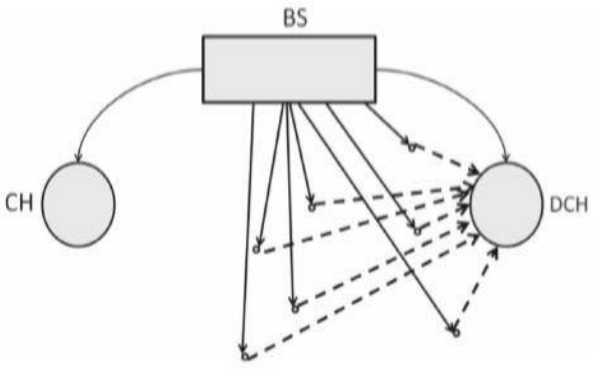


Fig 2. Cluster headship gets shifted to DCH

Scheduling and MAC Information Computing Phase

The sensor nodes can be in either of the two states active and dormant. Some sensor nodes are scheduled

for dormant state, which is a low-power state. A node dormant state does neither any sensing task nor any relaying task.

Operational Phase

During this phase, actual sensory data transmissions take place. The sensor nodes forward data toward the CH node according to their respective medium access time slots. The CH nodes remove the redundancies in the data sent by the sensor nodes by the process of data aggregation and finally forward the aggregated data toward the BS as per the communication pattern distributed by the BS. DCH nodes do only cluster management tasks such as monitoring the mobility of the nodes and exception handling.

Exception Handling Phase

This phase is an occasion alone. Due to the node mobility and the sudden death of some sensor nodes, the CH node may lose enough links with its cluster members. This may significantly degrade the throughput level in terms of packet delivery at the BS.If there is significant loss of connectivity with its cluster members, then the CH is asked to relinquish the charge of cluster headship, and a new one is selected either from the CH panel or one from within the two DCH nodes already selected. If a DCH node becomes the CH

Table 1. Simulation Parameters

Channel type	wireless channel
Propagation model	Two ray ground propagation model
Antenna type	omnidirectional antenna
Max packet in inq	55
No of mobile nodes	100,200,300,400
Routing algorithm	M-Leach,E2R2 protocols
BS Mobility type	Probability based mobility model
X dimensional topology	1960
Y dimensional topology	1400
Stimulation Time	10,20,30,40

V. SIMULATION RESULTS

In this section, we are going to compare the Energy and Throughput of M-LEACH Protocol and E2R2 Protocol through simulation results as follows:

Existing Architecture

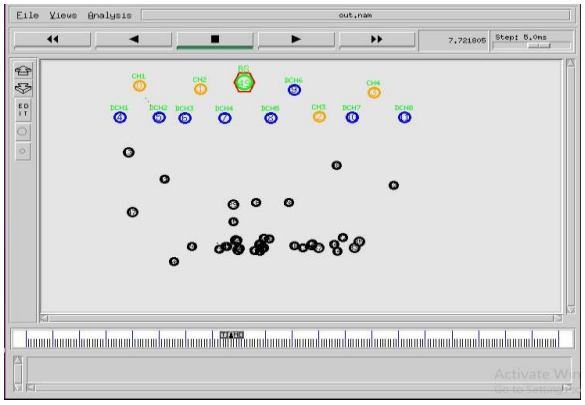


Fig 3. Existing architecture

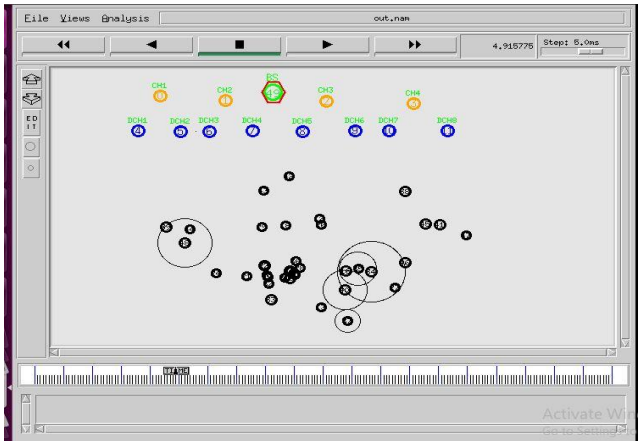
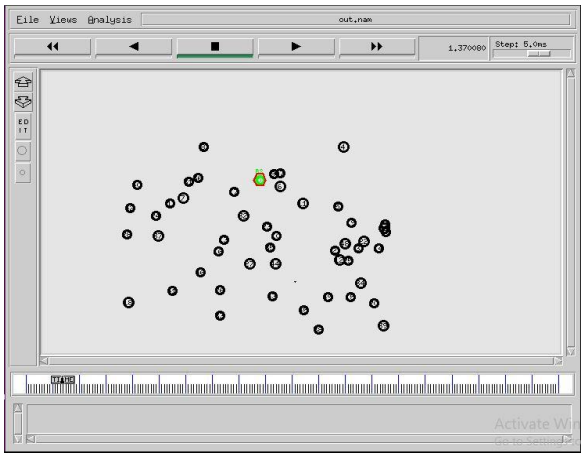


Fig 4. communication between the nodes

Here sensor nodes are communicating with BS.In this M-Leach Protocol the BS is fixed and sensor nodes are mobile.it will consume lot of energy when compare to the E2R2 Protocol, because the sensor field away from the BS. Then it will take more time to send the data then at that situation the sensor nodes will die soon. To overcome this we are implementing the E2R2 protocol.

In that both BS and sensor nodes are mobile. It will consume less Energy consumption. Then sensor nodes live life will be increased

Implemented Architecture



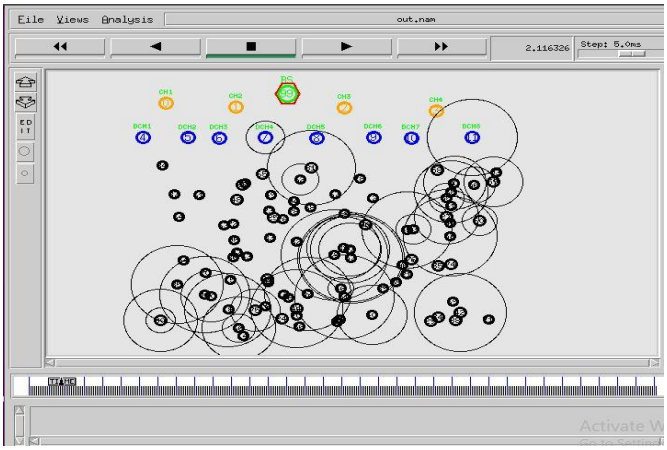


Fig 5. Data transmission from the sensor nodes to CH

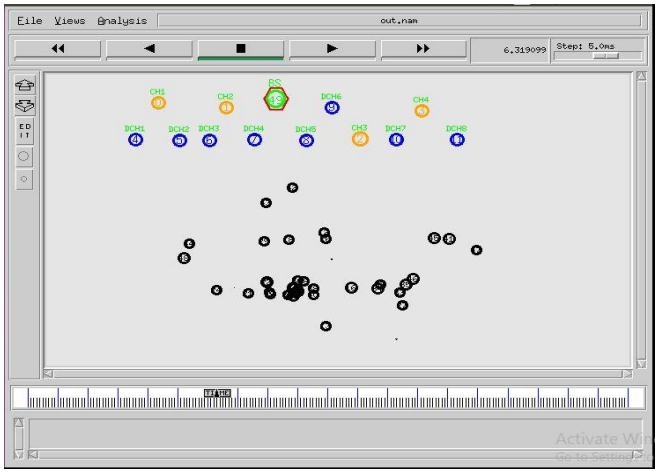


Fig 6. Cluster head shifted to DCH

In this above figure when sensor node energy losses the CH node will replace the highest residual energy of the DCH node. The CH becomes the DCH. The data send to the sensor nodes to BS through the multiple routes of the network.

Drop tails occurs: The sensor nodes send the data to the BS in which information will be losed.Due to the packet drop probability range is 0.0-0.2

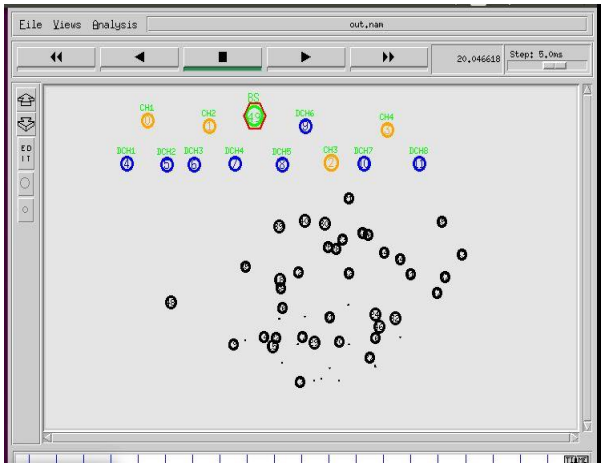


Fig 7. drop tail occurs

Energy consumption

Here we evaluate the overall average Energy of the M-LEACH Protocol and compare it to that of E2R2 Protocol. We are taking different sensor nodes at different energy level, and we are comparing it with the M-LEACH Protocol. For Energy graph on x-axis we are taking sensor nodes and on y-axis taking Energy. Energy Consumption comparison table.

N=400 nodes at x axis and y- axis Energy

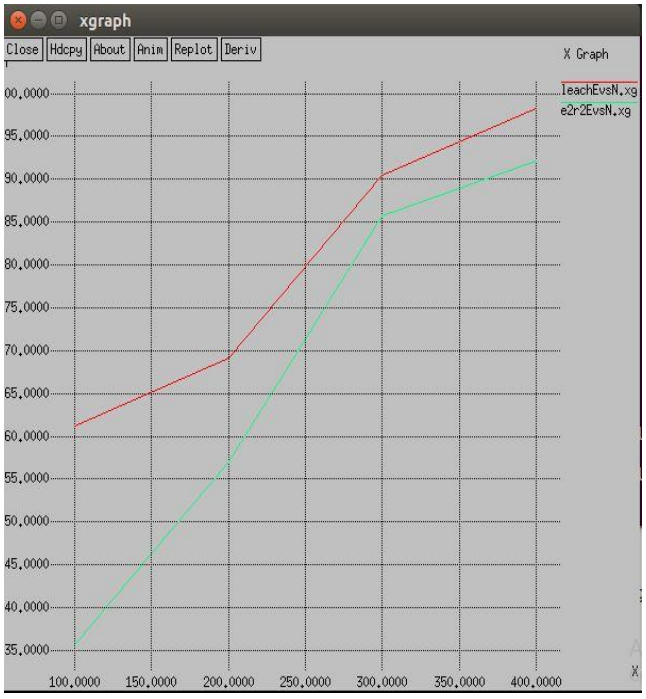


Fig 8. comparison graph energy vs sensor nodes

SENSOR NODES	M-LEACH PROTOCOL (Joules)	E2R2 PROTOCOL (Joules)
100	161.195	135.733
200	169.075	157.029
300	190.469	185.742
400	198.209	192.105

Fig 9. comparison graph throughput vs sensor nodes

Throughput:

The throughput is defined as the average number of data packets received effectively from all groups per unit time. Here we evaluate the overall average per-node Throughput of the M-LEACH Protocol and compare it to that of E2R2 Protocol. We are taking different sensor nodes at different mobility level, and we are comparing it with the M-LEACH Protocol. For throughput graph on x-axis we are taking sensor nodes and on y-axis taking Throughput.

N=400 nodes at x-axis and y-axis Throughput

By comparison of both protocols sensor nodes are increases throughput will be decreases the implemented protocol improved 15% throughput when compared to the M-Leach protocol. The throughput is improved.

Comparison of Energy Consumption

Mobility (meters/ sec)	M-LEACH PROTOCOL (Joules)	E2R2 PROTOCOL (Joules)
5	96.04	84.4657
10	133.84	123.985
15	158.289	150.211
20	160.123	154.023

Mobility on x axis and y axis Energy

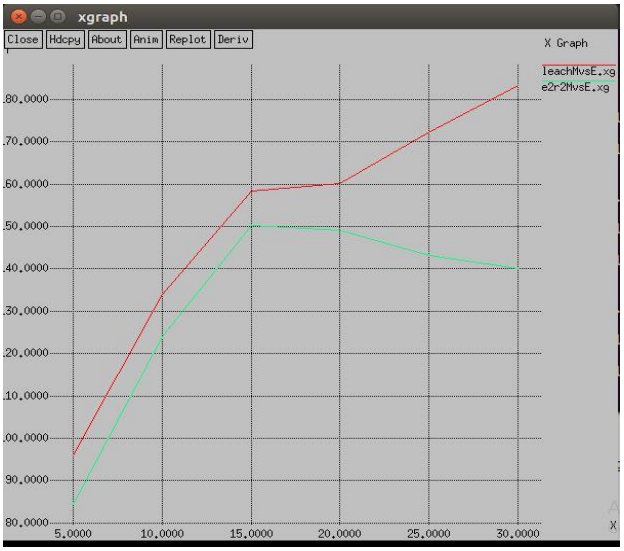


Fig 10. comparison graph Mobility vs Energy

The implemented E2R2 protocol taking mobility on x-axis and y-axis Energy consumption.Here we are increasing the mobility energy consumption will be increases.

Comparison of Throughput :

Mobility (meters/ sec)	M-LEACH PROTOCOL (Kpbs)	E2R2 PROTOCOL (Kpbs)
5	828.21	840.21
10	814.98	830.98
15	797.37	814.37
20	797.12	800.37

Mobility on x axis and y axis Throughput

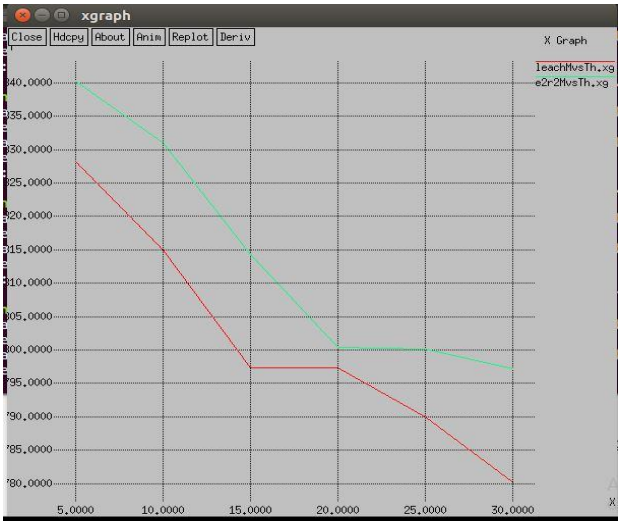


Fig 11. comparison graph Mobility vs Throughput

Here taking the mobility on x-axis and y-axis throughput. The protocol is efficient when it is compared with the M-LEACH protocol. The mobility is increases throughput will be decreses.Here we can observe on the above graph mobility E2R2 protocol is better efficient when compared to existing M-LEACH protocol.

VI. CONCLUSION

The effectiveness of the implemented routing Protocol approach is validated through simulation experiments. In this section various performance metrics used for evaluation of the protocol, simulator architecture, simulation environments and

experimental results and analysis are reported. The results of the implemented Protocol approach are also compared with another energy efficient routing approach for mobile wireless sensor networks, MLEACH. Energy consumed for E2R2 protocol is 18% less than M-Leach protocol. Throughput improved for E2R2 protocol is 15% more than M-Leach protocol.

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