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Optimized Hybrid Energy Efficient Clustered Protocol for Heterogeneous IoT Wireless Sensor Network

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Abstract

In recent years the Wireless Sensor Networks have become very popular due to the latest advancement and innovation in the micro electrical mechanical system which creates more opportunities to utilise the WSNs with their outstanding capability of sensing various type of environmental as well as other conditions. WSNs are comprised of large number of small and less expensive sensor nodes, these nodes communicate with one another with different set of rules called protocols. Performance of sensor node is generally affected by some protocols. There are nodes which are always operated on battery power therefore the energy utilisation will always be the prime concern of WSNs. The same analogy is applied for the WSNs in cyber physical system and for IoT milieu where different types of nodes or end devices have been found with different amount of initial energy. The proposed protocol therefore links the difference between the physical sensor networks and the genuine heterogeneous Cyber IoT environment. The paper shows the comparison between the Hy-IoT [1] and proposed by using the performance measures shown in result section.

Keywords: Wireless Sensor Networks (WSNs), Internet of Things (IoT), (Hy-IoT) hybrid IoT), Cluster heads (CH), Routing protocols, Micro Electro Mechanical System (MEMS).

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Introduction

IoT environment has many different devices that are non-uniform in their energy, their Internet accessibility, etc. These devices are typically disseminated into locales with various heterogeneity levels; going from homogeneous to close homogeneous, till coming to the high heterogeneous regions. Previously existed protocols productively treated either the homogeneous devices or heterogeneous devices. The Hy-IoT[1] protocol bridges the gap between the physical wireless sensor network environment and the genuine heterogeneous Cyber IoT environment. This research work targets not just giving a proficient hybrid energy aware clustering communication protocol for heterogeneous network like the IoT network which gives a real world sensor network computing scenario for analyzing at the proposed protocol namely Proposed, which is contrasted with generally existed protocols Like LEACH[2] and SEP.[3] This paper focused on improvising the Hy-IoT[1] protocol effectively and to modify the existing data transmission approach to route the data from cluster heads to the BS by multihop communication and by comparing the performance of the proposed scheme and existing Hy-IoT Protocol. The efficient cluster head (CH) selection lifts utilization of nodes energy and increase the network lifetime as well as packet transmission rate to the base station (BS). The proposed protocol efficiently utilizes weighted election probability for selecting cluster head based on the respective heterogeneity level of a particular region. By using the techniques proposed by SEP[3] and for another region LEACH techniques are utilized. The proposed protocol is for real world IoT networks which have different devices with different energy levels.

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Related Work

Rowayda A. Sadek[1] author in this paper focuses on diverse applications sensor platform like IoT (Internet of Things) which faces many challenges in the deployment of nodes and the cooperation of nodes or devices of different types. The main challenging task in IoT is to have an efficient final Stage energy aware communication protocol which can easily utilize the diversity between different devices and heterogeneity among them in terms of their energies of nodes with other linked things through Internet. As saving energy is a vital necessity in the low energy (limited battery life) nodes and also for the outsourced energy (Rechargeable nodes e.g. smart phone) nodes for green computing. IoT devices are typically dispersed into sections with diverse heterogeneity levels; ranging from homogeneous (Similar energy nodes) to near homogenous (Some nodes have similar energy and some have more energy than other), till high heterogeneous regions.

Heinzelman et al.,[2] Authors have done a pioneer research for the micro electronic sensor devices and named LEACH (Low Energy Adaptive Clustering Hierarchy) which is basically a self-organizing adaptive clustering protocol which is called LEACH and it used equalized energy load distribution among its member nodes in a WSN. The CH is selection is purely random basis and consists of some rounds in which each and every round is divided into three phases called Setup phase and study-state phase then data transmission phase. In LEACH the clustering task is rotated the nodes duration CH uses direct communication to forward the data packet from the CH. by creating clusters, therefore, the lifetime of the network increases. To inverse the lifetime of Nodes LEACH introduces randomized rotation of CHs which are selected on a prior probability. But LEACH protocol has some limitations like the CHs deplete more energy when it is farther from the BS. LEACH clustering terminates after finite interval number of iterations and does not guarantee good CHs distribution and not perform as desired in case of heterogeneous network.

$$T(n) = \begin{cases} \dfrac{p}{1 - p * (r.\, mod \frac{1}{p})} & if\, n \in G \\ 0\,, & Otherwise \end{cases}$$

Nodes whose residual energy is greater than average of the residual energy of the network, It generate random number between (0-1) and compare it with energy threshold value *T (n)* threshold and where the *n* belongs to *G* (number of the nodes, which is not become CHs since 1/p rounds) and. threshold value can be calculated by above equation (1). Where p is the percentage of a node to become CH, r is the current round.

Samragdakis Georgious, M. Ibrahim et al. [3], In this paper, authors implemented the impact of heterogeneity of nodes in terms of their energy in WSN which are hierarchically clustered. Authors proposed a protocol named SEP (Stable Election Protocol) which is a heterogeneous protocol as the previous protocols such as LEACH is not suitable of heterogeneous sensor networks. The whole network is divided into normal nodes and advance node (nodes with more energy than normal nodes). In this protocol both normal and advance nodes have weighted probability to become the CH for the network.

$$p_{opt} = \frac{k_{opt}}{N}$$

Assuming an optimal number of clusters K_{opt} and n is the number of advance nodes.

$$k_{opt} = \frac{\sqrt{N}}{\sqrt{2\pi}} * \sqrt{\frac{E_{fs}}{E_{mp}}} * \frac{M}{d_{bs}^2}$$

K_{opt} can be calculated by equation (3) where N is the number of nodes, E_{fs} and E_{mp} are the free space and multipath energy of energy model, M is the size of the field and d^2bs is the distance of nodes to BS. Then each node calculates p, percentage of the node to become CH by using theequation (2) According to SEP optimal probability of CH is shown in equation 1.2. Every node decides becoming CH in current round or not, a random number between 0 and 1 is generated for node. If this random number is less than or equal threshold *T(n)* of equation 1 for node then it is selected as CH.

$$p_{adv} = \frac{p_{opt}.(1 + a)}{1 + (a.m)}$$

S. Faisal, N. Javid et al.[4] proposed hybrid routing protocol ZSEPfor heterogeneous and near heterogeneous WSNs. This protocol is an extension of SEP[3] which include two types modes of relaying data, direct transmission and transmission through CH. The paper divides the network into three zones namely: Zone 0, head Zone 1, and head Zone 2. In zone 0, normalnodes aredeployedrandomly, in headzone 1, half of the advanced nodes are deployed and in head zone 2, other half of the advanced nodes are deployed. Advanced nodes here are nodes with more energy than the normal sensor nodes by a fraction of *m* of total *n* nodes. The protocol utilizes two technique to transmit the data to the base station, the first method is direct communication in which the normal nodes in zone 0 sense and collect the essential data and transmit is to the base station on the other hand the Head zone 1 and Head zone 2 is relaying the data to BS via the cluster head utilizing and appropriate clustering algorithm.

The selected CH aggregate data from all the member nodes and transmits it to BS. The selection of CH is done according to SEP [3] optimal probability of cluster head which is shown in equation 2 and the threshold $T(n)$ for selection of CH for normal nodes is also calculated from equation 1

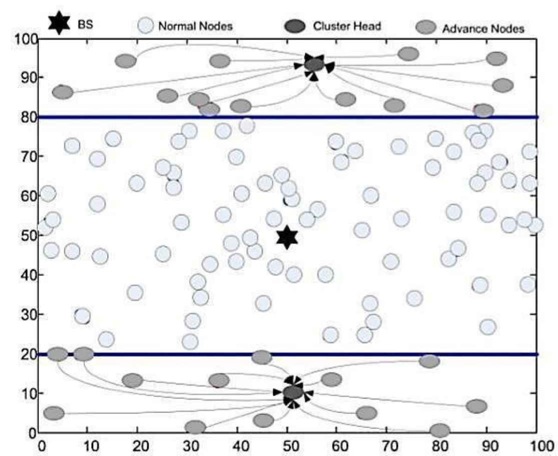


Figure 1: Network setup and data transmission in ZSEP [4]

whereas the probability of advance nodes p_{adv} is obtained by equation 3 therefore the threshold for advanced node is

$$T(n) = \begin{cases} \dfrac{p_{adv}}{1 - p_{adv} * (r.mod \dfrac{1}{p_{adv}})} & if\ adv \in G' \\ 0\ , & Otherwise \end{cases}$$

Where *G'* is the set of advance nodes that have not selected as cluster head till last $1/P_{adv}$ rounds.

Pallavi Sethi, Sumanti R. Saranhi,[5] defined the IoT and its architecture. According to the authors IoT is a model in which participating objects are fortified with sensors, actuators & processors contained embedded system objects to communicate with each other's for a meaningful purpose. Authors also proposed a novel classification for IoT technologies, features of the technologies and their impact in human life. The paper compares the definition of IoT by different authors, tells about the potential application of IoT in today's scenario and scopes of WSN with IoT.

The *Transport layer* the sensors data is handover from the perception layer to the processing layer and vice-versa through the wireless networks such as Bluetooth, RFID, NFC, 3G and through LAN.

The *Processing layer* analyzes stores, and process huge amount of data which is to be gathered by the sensors deployed in the network in transport layer. It incorporates data processing techniques such as databases, big data etc. The *Business Layer* deals with the IoT system which includes profit models, applications, user's privacy etc.

Sudhanshu Tyagi, Neeraj Kumar, 2013[6] In this review paper authors present a methodical review on different LEACH based clustering & routing techniques based on for WSN. A full assessment of the comparative benefit and disadvantages of many aspects of LEACH protocol is given in the article. The author explains the basis of LEACH paper along with the radio model of LEACH protocol. It also explains the categorization of the LEACH protocol. Also tells about LEACH related routing protocols of WSN as well as clustering based & data transmissions through multi-hop communication. The paper also explains heterogeneous protocols like EAHP, HEEP (hybrid energy aware distribution clustering protocols) in great details.

Meena Malik and Yudhvir Singh[7] this paper shows a point by point audit and investigation of LEACH Protocol.

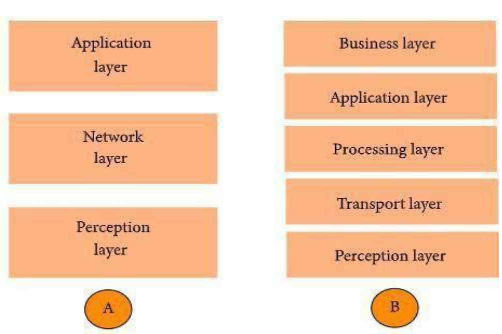


Figure 2: Two Layers and five Layer Architecture of IoT[5]

Correlation of different network parameters is done as tables and charts. The simulation work has been done by utilizing own set of parameters and in the last of the paper conclusion is drawn. WSN is a system of detecting nodes without having any centralized controller. Its improvement is rapidly growing and that is the reason there is an immense field for research around there. Sensors depend completely on the trust of their battery for power, which can't be rejuvenated or substituted. So, the structure of Energy efficient protocol is fundamental in regard to improve the system lifetime. LEACH is an efficient clustered protocol, which effects the lifetime of the system.

IoT Network

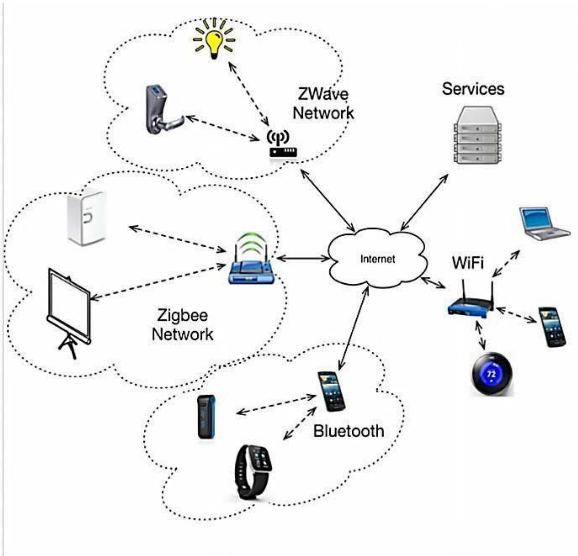
The IoT is described as a Model[8] in which items fitted with actuators, sensors and transceivers interact to serve a significant objective. It cannot be understood as a single technology but it is accumulation of several technologies that work together. Sensors and actuators are equipment that aid in physical environment interactions. In order to draw helpful conclusions from this, the information gathered by the detectors has to be saved and handled intelligently. Note that the word sensor is defined generally; as soon as it contains information concerning its present condition (inner state+ environment), a cell phone or even a CCTV camera can be counted as a sensor. Actuators are instruments that embrace control power (mostly in the form of an electric signal) and alter the physical system through power generation, movement, warmth, flow, etc. Data can be processed and stored on the network edge or on a remote server. When information can be pre-processed, it is usually performed on either the sensor or some other nearby unit.

Communication in IOT

As the Internet of Things field is raising very fast, a wide range of heterogeneous smart devices are connected to the Internet. IoT systems with minimal computation and storage resources are driven by battery. Due to their constrained nature, multiple communication difficulties arise as follows:

- *Address and identity*: As millions of smart devices are linked to the Internet, a distinctive address must identify them based on which they can interact. For this to happen, for every smart object we needed a large address space and a unique address.
- *Low- energy communication :* Transmission of information between computers, in particular wireless communication, is a energy consuming job. Consequently, we need a way to communicate with limited energy use.
- *Routing protocols*: We need a set of rules or protocol which can derive the network with lesser memory requirement and efficient communication pattern.

IoT systems[9] usually linked to the Internet via a complicated protocol stack that needs a lot of energy as well as storage from linking computer systems. The IoT devices can also be connected locally through Non-IP communication



channels like Bluetooth, RFID, and Zigbee etc. these connection methods are popular but they are limited by their communication ranges. And their applications fall under PANs (Personal Area Networks).

The IP stack had to be modified to facilitate low-power communication by the IP stack in order to increase the range of such regional networks. 6LoWPAN includes IPv6 with low-power personal area networks, among other alternatives. The PAN with 6LoWPAN is comparable to regional networks, with significantly reduced power consumption.

Proposed Hybrid Protocol for IoT

The authors in the paper[1] have described the clustering approach in internet of things scenario driven by traditional LEACH[2] protocol in the super region (in which the nodes have more energy than other nodes in the network) and SEP[3] protocol in the normal region. The proposed protocol considers one hop communication among the CH and the base station, it would consume much of the energy of the cluster heads over the long-distance communication with the base station. Also, in the first phase of the existing scheme, Hy-IoT protocol would follow CH advertisement process in which every eligible node will broadcast an advertisement message for the election of CH. This procedure will expend huge measure of energy, as nodes will be engaged with the broadcasting procedure. Since, CHs already consume more energy (first in broadcasting the advertisement and second in relaying the data of its member nodes to the BS), therefore, focus must be given on alternate or modifying the current data relaying scheme.

The requested message includes node-ID, CH-ID, along with the same spreading code with CSMA with a MAC protocol. The cluster head used CSMA as a MAC protocol to pass an advertising message to the nodes of the members with its ID, header to display it as a statement message and a spreading code that is essential to minimize inter-cluster interference. Likewise, after cluster formation, each CH declares its TDMA plan for its sensor nodes to encourage getting information from nodes in the cluster in their slots. Every node awakens just during its TDMA slot to communicate its information to CH and goes into sleep mode once more.

Proposed Methodology

- Initially every sensor node will start advertisement process, where it broadcasts advertisement message to all the sensors in its communication range. This is the first step in the clustering process.
- If any node receives multiple advertisement messages, then it would join the cluster head for which energy is highest. Upon choosing the cluster head, the member nodes broadcast a packet to it informing about its joining to CH.
- If the non-CH node broadcast a join packet to CH to enter its cluster, its remaining energy will also be transmitted. The current CH would in this way gather every information from its cluster members. This information will be utilized to turn the CHs for the consequent rounds. The current CH will sort the individuals in the request of highest energy and least separation from the base station. The member at the top of the list would be selected as CH for the subsequent round. Thus, at the beginning of every round, the CH advertisement phase would be avoided.
- The existing scheme considers only single hop communication between BS and the CHs in the normal region. In the proposed work, we aim at formulating the chains among relay nodes (selected from within the clusters) to forward the data from CHs to BS.
- Once the various paths have been formulated, every CH would select a member node from its cluster to relay the data of the child CH. The selected member node would be the one having highest residual energy and least distance from the CH and BS. Thus, the path from cluster heads to the base station would be through the relay nodes.
- However, if the chosen relay node is to assume the role of CH in the successive round, then node having second highest energy will be chosen as relay node. Thus, every CH would now relay the data to the chosen relay node, which would act as parent to child CH. This would reduce the load over the CH to relay the data of other CHs as well.

By this methodology the Load of the CH is reduced significantly, which in turn increases the throughput of the network. Further the Network model and the Energy model [6] utilized here are same as used as for a typical Wireless Sensor Network.

Radio Energy Model for WSN

The selected CH transmits a Packet to BS. So, every sensor node consumes some part of its energy in communication process. Therefore, for estimation of WSNs energy utilization, it is essential to calculate consumed energy in communication

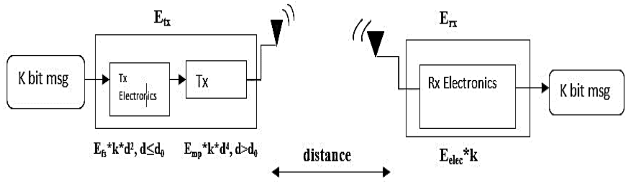


Figure 4: Radio energy model

process. Figure 4. Shows the estimation of consumed energy for a simple radio model, it is the first order radio energy dissipation model which uses both the free space and multipath fading channel models. The choice of free space and multi path fading models depends on the range of d_0 which is the threshold distance between two wireless radios, if the distance between transmitter and receiver is less than or equal to the threshold distance d_0, the free space model is adopted else the multipath propagation model [6] is espoused. The energy necessary to send the ' k ' bit message from the transmitter to receiver over a range of 'd ' may be calculated as:

$$Etx\,(k\,,d)= \begin{cases} E_{elec} * k + E_{fs} * k * d^2, & d \le d_0 \\ E_{elec} * k + E_{mp} * k * d^4, & d > d_0 \end{cases}$$

Where d0 is the threshold distance which is denoted as:

$$d0 = \sqrt{\frac{E_{fs}}{E_{ms}}}$$

The energy spent to receive this 'k' bit message can be calculated as:

$$E_{Rx}(k) = E_{elec} * k$$

If also therecipientconducts informationaggregation in the obtained k-bit signal than the energy spent is:

$$E_{Rx}(k) = (E_{elec} + EDA) * k$$

Where E_{elec} indicates the energy required to run the electronic circuitry which is dependent upon the type of coding scheme, type of modulation and filtering techniques, here $E_{fs}d^2$ and $E_{mp}d^4$ are the energy consumed by amplifier and which is required to transmit k bit message over distance d for free space and multipath communication. An assumption has been made for this model that radio channel is symmetric; it means for same conditions energy consumption in both direction between two nodes is same.

Cluster Head Selection Phase

The CH determination stage is the crucial stage in the WSN environment. In the proposed methodology the node picks the appropriate Cluster-head as indicated by numerous criteria; like its current position, its remaining energy, distance from the Cluster Head; unlike LEACH which utilizes CH selection threshold value and having fixed likelihood of CH choice. SEP [3] uses the weighted election probabilities of every node to be CH in accordance with their energies. For the total N number of nodes, number of CHs K is different in each round and the length C_r of each cluster is varied and C_r can be expressed as $C_r = N/K$. When the instability period begins, the nodes can either link to the announced CH from the Superior region R_s, or from the regular region R_{ra} depending on their range and energy consumption.

Superior Nodes Cluster Head Selection

As Superior locale has homogeneous nodes with greater energies; they are viewed as power stable gadgets. The selection of the Cluster-head in this particular area is done by utilizing the LEACH protocol.[2] As the nodes in region R_s are energy-positive nodes, yet consumption should be reduced further for the sake of green computing.

The Base Station computes average remaining energy of the network and optimum number of CHs required (k_{opt}) for the network then the BS broadcasts this information all over the network, by this process each node knows exactly about the average residual energy of the network and minimum number of CHs. As mentioned above the optimum number of CHs can be calculated by the equation followed as in:[10]

$$k_{opt} = \frac{\sqrt{N}}{\sqrt{2\pi}} * \sqrt{\frac{E_{fs}}{E_{mp}}} * \frac{M}{d_{bs}^2}$$

Here N denotes the number of nodes, E_{fs} and E_{mp} are the free space and multipath energy of energy model, M is the size of the field and d^2_{bs} is the distance of nodes to BS. Then p is calculated by each node which is the percentage of the node to become CH by using the equation (2) and threshold is determined by equation (4).

Regular region cluster head Selection

Regular R_{ra} area has a random distribution of the majority of normal-nodes / things with limited amount of residual energy along with a few advanced-nodes. The election of the CH is done in this region by utilizing the SEP in order to consider the residual of energy content in each round. From equation (1.3)

Cluster Formation Phase

Once the CH is selected, an advertisement message is broadcasted by it to the other nodes in the network. Nodes get information of their next CH by this message. The Received signal strength and distance from the CH are the fundamental parameters for the nodes to choose which cluster head they will connect with. Nodes chose closest CH to limit the energy consumption.

Every node monitors its three closest CHs and ranks them in a descending order of the distance to them, from the farthest-the closest one. If the first one on the list reaches its maximum members at that point, it appoints a node to the next CH in the list to limit the latency of transmission, to ensure the balance of load, and to increase the life of the system by an increment of one node's time. The chosen CH utilizes CSMA to communicate an advertisement message which contains its ID, header to show it as an announcement message along with spreading code which is important to decrease the inter cluster interference. Each CH declares its TDMA plan for nodes which belongs to it and encourages accepting data from nodes in the cluster in their time slots. Every node awakens only during its TDMA schedule to transmit its information to CH and goes into rest mode.

Simulation and Results

This section presents the details about the implementation of the proposed protocol for routing in IoT heterogenous network. The proposed protocol is compared to the Hy-IoT [1] in real world heterogeneous IoT environment. The implementation of the proposed algorithm was done in MATLAB R2016a version 9.0.0.34136.

Simulation setup and parameter initialization

N =100 sensor nodes which are deployed over a sensor field size of 100m x 100m randomly and the sink node or Base Station is located at predefined position with respect to energy criterion as shown in Figure 4. Assume that 80% of normal-nodes are deployed and 20% of advanced nodes are there. The position of the sink node is taken as in four different cases by changing the location of the base station at different predefined locations in the field such as X=50, Y=50 (center position), X=50, Y=0 (lower middle), X=100, Y=50 (middle corner), X=50, Y=80 (upper middle), X=100, Y=80 (right corner). These five cases are compared in terms of the life time of the network in different case. The radio characteristics and parameters used in simulation are in accordance with Table 1. The plotted field area has two major regions, first regular region; R_{ra} which contains the regular nodes (normal-nodes) expressed as 'aa∈M' with red circles. and they are deployed randomly in region limited to (0 <X ≤100; 0 <Y ≤ 80), While the second superior region has superior nodes; which are located randomly in region (0< X≤100; 80< Y≤100) (bb∈N) with black circles as shown in figure below. The total devices in this IoT environment in M+N.

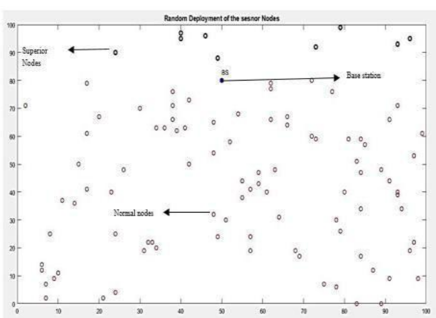


Figure 5: Random deployment of nodes in the two regions: regular and superior

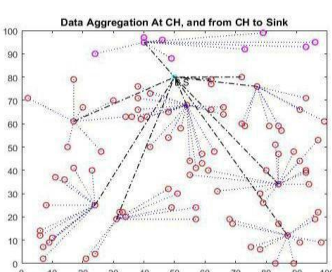


Figure 6: Data Aggregation & transmission to sink node for rounds for X=50, Y=80

Table 1: Simulation Parameters

1	Network Size	100 m × 100 m
2	Number of nodes (N)	100
3	Packet Size (K)	4000 bit
4	Initial Energy (E_0)	0.15 J ,0.3 J ,1.5 J
5	Data Aggregation energy (EDA)	5nJ/bit
6	Transmission (E_{TX}) & Reception (E_{RX}) Energy	5nJ/bit
7	Amplification energy for short distance (E_{FS})	10pJ/bit/m^2
8	Amplification energy for long distance (E_{amp})	0.013pJ/bit/m^4
9	Optimal Probability P_{opt}	0.1

Simulation results

This section shows the results obtained after the implementation of proposed protocol and compare the performance of our proposed protocol with the existing Hy-IoT protocol, applicable for real world IoT heterogeneous networks. The performance of the proposed protocol is measured by some performance metrices like which are shown in below through the graphs.

The simulation situation shows the impact on network efficiency of the existence of various energy heterogeneity. It has been assumed that 80% of normal nodes and 20% of superior nodes are deployed. Along with it a 10% of advanced nodes with approximately doubled energy are randomly

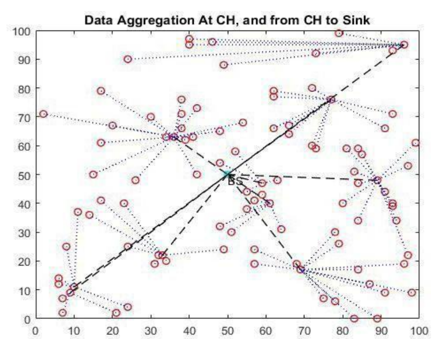


Figure 7: Data Aggregation & transmission to sink node for X=50, Y=50

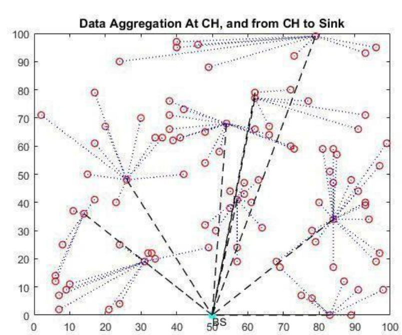


Figure 8: Data Aggregation & transmission to sink node for X=50,Y=0

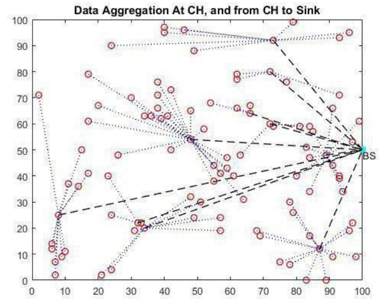


Figure 9: Data Aggregation & transmission to sink node for X=100,Y=50

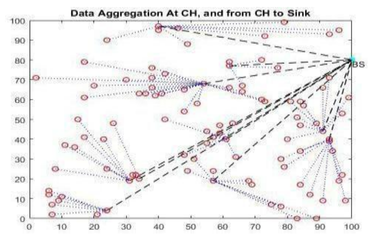


Figure 10: Data Aggregation & transmission to sink node for X=100, Y=80

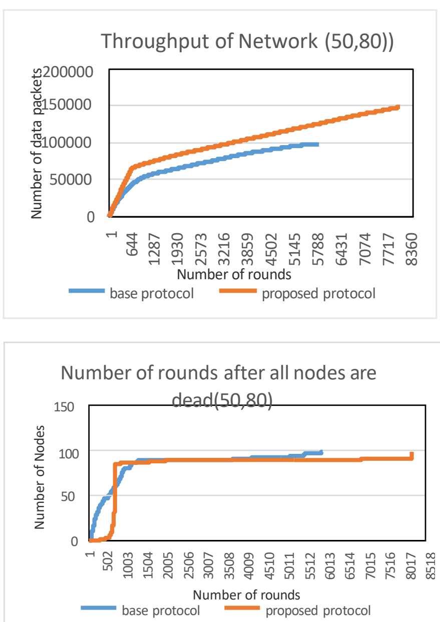


Figure 11: Performance of the network at X=50, Y=80

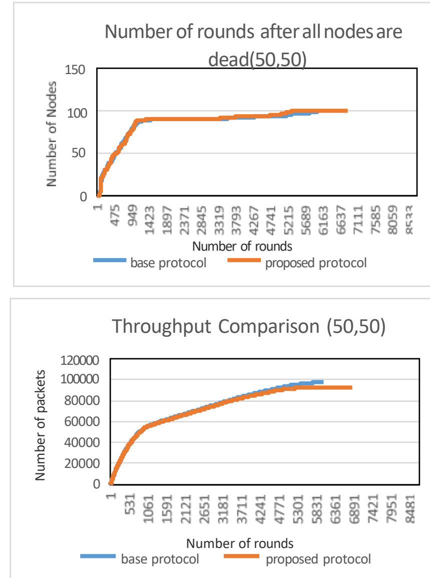


Figure 12: Performance of the network at X=50, Y=50

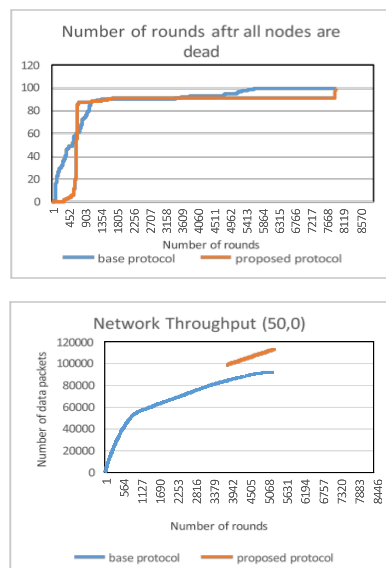


Figure 13: Performance of the network at X=50, Y=0

distributed in the regular region R_{ra} and 10% advanced are randomly distributed in the superior region R_s.

We have placed the base station at different locations in the network and calculated the performance in terms of total active time of the network and overall throughput of the network, which is shown by the figures below.
The aggregation of the data sent in the terms of packets at to the sink node or the base station is shown here by Figure 6 to 10. We can observe that the data is collected by the cluster heads from the nodes and these selected Cluster Heads then send the data after aggregating to the base station. The blue dotted line shows the data flow from nodes to the selected cluster heads and the black dashed line shows the transmission of the aggregated data to the base station.

We have shown the results by considering all the cases of the placement of the base station in the network and comparing it with the base paper which is shown here from the Figures 11-15 the performance of the network is shown by placing the base station firstly at the upper middle corner, centre, lower middle, middle to the right most position in the network. At last the Figure 16 shows the overall performance in the form of a bar graph and detailed comparison from the base Hy-IoT[1] with our proposed protocol.

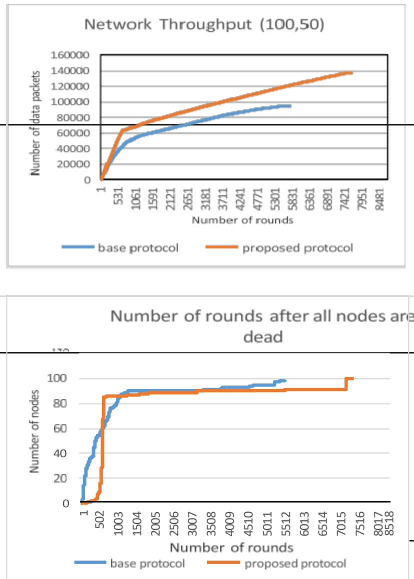


Figure 14: Performance of the network at X=100, Y=50

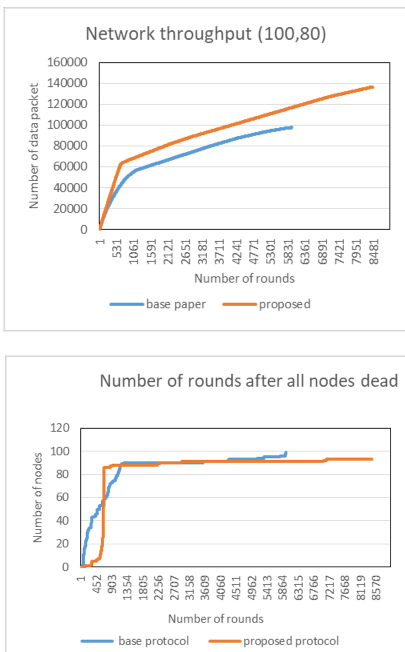


Figure 15: Performance of the network at X=100, Y=80

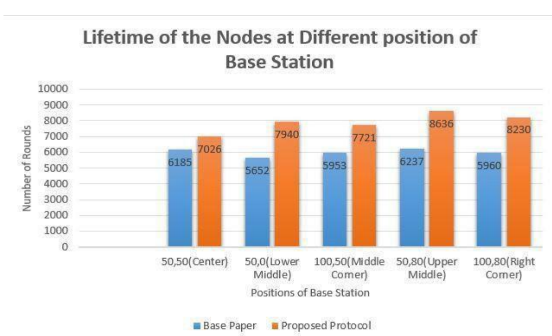


Figure 16: Comparison of Life time of the nodes

Table 2: comparison of FND with Base Paper

Position of base station	*Routing protocol*	
	Hy- iot	*Proposed protocol*
50,50	66	75
50,0	68	333
100,50	63	213
50,80	70	232
100,80	65	118

station	*Hy- IoT*	*Proposed protocol*
50,50	6119	6201
50,0	5585	7606
100,50	5889	7508
50,80	6168	8405
100,80	5597	8330

Network Lifetime

- **Stability Period** shows the start of the network operation till the death of first node in the network. These results have been compared for Hy-IoT and proposed protocol performance after simulation in table 2. From the comparison it is clear that number of rounds after the first node of the network is dead is maximum in the case of the X=50, Y=0 position of the base station with a percentage increase of 389.7%.
- **Instability Period** is theperiod from the death of thefirst node till the last node death of the network, expressed in rounds. These results have been compared for Hy-IoT [1] and from the table 3, we can say that the X=50,Y=80 position of the sink node holds the maximum number of rounds even in the instability period. Then the X=100, Y=80 location give better results after the first case. The result is 36.2% improved in case of the X=50, Y=80 position.

Number of packets sent to Base Station

Table 4 marks the total number of data packets transmitted towards the Base Station from the selected CHs over rounds of communication. From the figures shown above we can see that due to improvement in network lifetime the throughput of the network increases. The immediate communication between the neighbouring nodes and the base station results in a higher amount of packets transferred from closer sensor nodes and cluster heads to the sink node or Base Station as compared to other cluster algorithms, after comparing the results with the base protocol Hy-IoT[1] in different positions

Table 4: Comparison of packet delivery at Base station

Position of base station	Routing protocol	
	Hy-IoT	Proposed protocol
50,50	97393	145285
50,0	92387	133994
100,50	95198	137486
50,80	98132	148295
100,80	97667	139295

Table 5: Number of rounds after all nodes are dead

Position of base station	Routing Protocol	
	Hy-IoT	Proposed protocol
50,50	6185	7026
50,0	5652	7940
100,50	5953	7721
50,80	6237	8636
100,80	5960	8450

of the sink nodes we can say that the percentage increase of throughput by 38.4% in case of X=50, Y=80. And 41.7% in X=100, Y=80.

Number rounds after all nodes are dead

Table 5 shows the number of dead nodes after a certain round in the network which lost their energy and are dead. This process affects the stability period of the network as well as throughput of the network. By analysing the table below we can say that the lifetime of the network considered here is maximum in the case of X=50, Y=80 which is also shown by the base protocol but by modification of the data relaying scheme the overall network lifetime is enhanced by 38% by our method. In every position of the base station the proposed protocol gives better result.

Conclusion

In this paper we optimized the Hy-IoT protocol and compares its performance with the proposed protocol for the IoT heterogeneous wireless sensor networks as the traditional protocols such as LEACH[2] and SEP[11] deals with either homogeneous networks or either heterogeneous network, but real world IoT scenario is completely different as the IoT networks comprises of different devices having different energy levels like some devices have ample energy and some have to charge frequently. The described IoT network architecture has nodes with different heterogeneous levels of energy that dispersed in different regions in the network namely Regular region R_{ra} and superior region R_s. and an optimized and more efficient data relaying technique is used for data transmission. The advertisement phase is avoided so as to improve the life time of the network. Multihop replaying techniques are used and chains are formed amongst the CHs to relay the data from the distant node efficiently.

We have done a through comparison of the performance of the network with the existing work of Hy-IoT [1] and we compared all the best possible positions of the base station (sink node) in the network by taking 5 cases of the base stations helps us to determine that the position X=50, Y=80 is the optimal position and gives more improvised results for all kind of performance metrics which are considered crucial of any Wireless Sensor Network like network life time, stability period, instability period, network throughput by considering number of packets sent to the base station. We can say that by our proposed method the existing protocol is improved approximately 34%.

The future work can be considering efficient merging of MAC protocol in the above proposed protocol, considering the region partitioning while analyzing the network and well as considering the GPS for the clustering topology.

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