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An Optimized Ring Based Clustering Protocol In Heterogeneous Wireless Sensor Networks

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ABSTRACT
A heterogeneous ring domain communication topology with equivalent zone in each ring is introduced in this investigation with an end goal to take care of the energy balance problem in unique RPL(IPv6 Routing Protocol for Low Power and Lossy Networks The wireless sensor networks have pulled in much consideration in light of various candidates in different fields. In the wireless sensor networks, the sensor nodes are circulated haphazardly in supervision and control area. In these networks, the sensors utilize a restricted nourishing source that after its completing, organize lifetime closes as these sources are nonrenewable. With the end goal to utilize progressively and increment the lifetime of such system, scientists are continually searching for the techniques by which they can diminish the energy consumption. Obviously, information change and communications expend the most energy consumption of these networks. To build the system lifetime, we ought to deal with the energy expended at nodes by a few plans. Clustering is a proper technique to achieve this objective and additionally topology control administration in the wireless sensor networks.
Keywords: wireless sensor nodes, lifetime, clustering, routing algorithms, energy consumption

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I. INTRODUCTION

Wireless sensor networks (WSNs) involves hundreds or thousands of minimal effort sensor nodes. Once sent, sensor nodes gather the data of enthusiasm from the sensors, performs nearby handling of these information including quantization and pressure, and forward the information to a base station (BS) straightforwardly or through a neighboring hand-off hub [1].It is utilized in immense number of utilizations for wireless sensor networks, for example, military, business, interruption recognition and mechanical, human services, calamity and safeguard tasks, and so forth. Numerous conventions have been proposed for expanding the energy effectiveness and lifetime of the wireless sensor networks, for example, LEACH, HEED, PEGASIS and PEDAP. All the previously mentioned conventions have different systems to upgrade the lifetime of the wireless sensor networks. Sensor nodes detects the information from the earth where it is found and send it to the base station. Prior to transferring the information to the base station, the sensor nodes need to know the data about neighboring nodes and it's ID [4]. There are two sorts of communications between group heads and the base station, single-jump communication and multi-bounce communication. In multi-bounce communication clustering algorithms, the energy consumption of group heads comprises of the energy for getting, conglomerating and sending the information from their bunch individuals (intra-bunch energy consumption) and the energy for sending information for their neighbor bunch heads (between group energy consumption)[5]. In clustering networks, the imbalanced energy consumption among nodes is the key factor influencing the system lifetime. With the end goal to balance the energy consumption among nodes, clustering algorithms for networks are utilized. An enhancement over the convention is the GSTEB convention which chooses the bunch head dependent on energy level of the sensor nodes, the hub which is having higher energy level will turn into the group head[4]. Wireless Sensor Network (WSN) [1] is quickly developing in the data world and this is the region of research as of late. WSN region is the accumulation of the modest sensor nodes furnished with coordinated detecting, information gathering, preparing capacity and constrained storage room too. WSN gives the stage to the sensor nodes for detecting and monitoring the system territory. The stages of wireless sensor organize are wards on battery control. WSNs have been utilized in significant and touchy applications to spare the lives, for example, friendliness, country security, natural monitoring, and framework frameworks. WSNs have been utilized in military application too. Sensor nodes are minor gadgets, each individual sensor hub has capacity of information detecting from possess detecting reach and preparing at that point transmits to the at least one information accumulation point. Each little hub has particular non battery-powered and imperative battery which has a constrained energy control. Sparing the energy of the hub is the enormous test in light of the fact that each sensor hub has its very own different non replaceable battery with constrained lifetime and can't be revived during detecting the information. Around there, the diverse energy effective directing methods are as of now proposed to enhance the lifetime of the system. The extremely mainstream plot (Lower-Energy Adaptive Clustering Hierarchy) [2] [3] is utilized for WSNs.

II. RELATED WORK

Presently days, many clustering algorithms have been proposed to encourage communication and information handling in sensor networks. Be that as it may, the problem of unbalanced energy consumption exists in wireless sensor networks. We notice the most related papers to energy effective unequal layered clustering. In [1] the creators propose a multi-jump communication between the information source and base station which is more energy productive than single-bounce communication. Be that as it may, the problem areas problem stays unavoidable in between group communication. So the group goes to the base station are over-burden with substantial hand-off movement and they will kick the bucket first. In [2] the creators research the problem of drawing out the lifetime of a system, by considering the ideal group estimate. In view of this, they propose a transmission plot, which additionally builds the system lifetime. In [3], the problem of unbalanced energy consumption is settled by unequal layered clustering model. The system display is partitioned into two rings of unequal sizes. The creators presume that unequal layered clustering is superior to anything measure up to clustering in multi-jump show. In LEACH [4], single-bounce clustering calculation for wireless sensor arrange is proposed. Every hub will have certain likelihood to wind up a bunch head. Each bunch head gathers the whole totaled bundle and advances them to the base station by single-bounce. In EEUC [5], the creators propose Energy Efficient Unequal Clustering convention. Nodes are disseminated into groups of unequal size. So the bunch makes a beeline for the base station have littler sizes than those from the uttermost away. The overhead of group setup in EEUC is high. In ULCA [6] is an outstanding unequal layered clustering way to deal with alleviate the problem areas problem. In ULCA nearby rivalry and part join component is received which diminishes the overhead than EEUC [5]. In [7] the creators propose an Improved Energy Efficient Unequal Clustering (IEEUC) calculation. The nodes rivalry range will be balanced dependent on the bounces to base station. Energy consumptions are better in IEEUC contrasted with EEUC. Paper [8] proposes a Data– collected Unequal Clustering (DUC) directing convention, where fundamental group head (MCH) are chosen. All the group heads total the information and check for excess lastly forward them to the base station. In [9], Energy Balancing Unequal Clustering Protocol (EB-UCP) is proposed. System demonstrate is partitioned into numerous rings. The rings near the base station have higher likelihood than that are further far from the base station. Notice [10] expands LEACH [4] by considering the leftover energy and intra-group cost data. Provisional bunch heads are chosen lastly group heads are chosen.

III. CLUSTERING

In a sensor network, the sensor nodes are divided into different groups, and they are allocated geographically adjacent into the same cluster according to their communication range. Every cluster would have a leader, often named as cluster head (CH). The role of CH is to organize the clusters, including data aggregation, data forwarding, communication between base station and the sensor nodes. Cluster heads can consolidate the data and send it to the base station as a single packet, which helps to reduce the overhead. Within the cluster organization there can be both intracluster communication and intercluster communication. Clustering is essential for sensor network applications, where a large number of sensors are deployed for sensing purposes. If each sensor nodes starts to transmit data in the network, large amount of data congestion and collisions may exhibit. This leads to loss of energy rapidly from the sensors. Clustering is a method which is used to overcome these issues. In other words, clustering improves the scalability of wireless sensor networks. It reduces the communication overheads among the sensor nodes. Nowadays, many clustering algorithms have been proposed for sensor networks aiming to improve the lifetime of the nodes. To achieve maximizing network lifetime the whole network is divided into different clusters.

A. Benefits of Clustering

The foremost benefits of clustering in wireless sensor networks are:

1. Clustering provides the spatial reuse of resources to increase system capacity. For example, if the

clusters are not neighbors, they can use the same frequency for wireless communication.
2. It reduces collisions caused by contention for the channel.
3. It provides resource utilization and reduces energy consumption in the network by reducing the sensor nodes that take part in long distance transmissions.
4. Clustering reduces the size of the routing table stored at the individual nodes by localizing the route set up within the cluster.
5. The CH can prolong the battery life of the individual sensors and the network lifetime as well by implementing optimized management strategies [5]
6. A CH can minimize the rate of energy utilization by scheduling activities in the cluster (can make the nodes to sleep mode).
7. Clustering can also conserve communication bandwidth since it limits the scope of inter-cluster interactions to CHs and avoids redundant exchange of messages among sensor nodes [5]
B. Design goals of Clustering Design goals targeted in traditional networking provide little more than a basis for the design in wireless sensor networks [6]. Clustering algorithms plays an important role in achieving the targeted design. There are several attributes which are to be considered while designing the clusters namely,
1. Formation of clusters
2. Section of cluster head and its capabilities
3. Synchronization
4. Data aggregation
5. Error recovery and maintenance
6. Quality of service
7. Real time application using clusters

IV. OVERVIEW OF VARIOUS CLUSTERING BASED ROUTING ALGORITHMS

In cluster-based routing techniques [1], a cluster of candidate parent nodes gets formed. These set of nodes utilized in multipath solutions and in situations where parent node compromise than optimal node among the candidate parent node selected for packet transfer. Thus, it solves the problem of single-parent failure. Recent studies investigated and used clustering algorithms for routing improvement in RPL in various scenarios. Routing techniques that can use to improve RPL performance [1] are opportunistic routing [6] and network coding [7]. Opportunistic routing uses the concept of multiple paths as these multiple-paths will perform better than the single path networks by using multiple-paths efficiently and combining poor paths together in one or more reliable links, but multiple-paths suffers from coordination problem and duplication of packets, so one has to deal with those issues also. There are protocols which use the concept of opportunistic routing i.e. ORPL [8] (opportunistic routing), CRPL [9] (cluster parent based RPL) etc. While on other hand, coding techniques used in network coding for improving RPL performance [7].

There are various clustering based routing algorithms where researchers worked on problems of RPL and provided their solutions. Here we discuss some of routing protocols, which uses clustering algorithms to provide better results than RPL. These protocols compared at the end of the section in Table I (Comparison between Clustering based routing algorithms).

A. IRPL: Improved RPL

IRPL[10] uses the concept of clustering in network and topology control model. Topology control model, which divides the network into heterogeneous clusters varying in sizes based on their residual energy and according to their relative position inside the cluster. Subsequent nodes are chosen with optimal angle consideration for efficient packet forwarding in inter-ring cluster's communication, which helps in reduction in energy consumption.

Heterogeneous cluster and a cluster-head rotation mechanism used for balancing energy consumption. To balance energy among nodes throughout ring levels; numbers of the clusters are increased in the inner-ring network and thus reducing the number of nodes in the cluster, which helps to attain energy balance between outer ring layer and inner ring layer's energy consumption respectively. Overall energy consumption of IRPL is smaller when compared to RPL[10].

B. ORPL: Opportunistic RPL

Extension of RPL – ORPL (Opportunistic RPL)[8], which improves Packet Delivery Ratio (PDR), achieves a lesser number of retransmissions and low protocol overhead in comparison to RPL. ORPL uses the property of broadcast nature of wireless networks and decides whether to do forward selection or not based on the result after receiving data from other nodes. On receiving a packet, the node decides whether to take part in packet forwarding or not. ORPL fixes RPL issues via considering candidate parent sets (CPS), also considers only those candidate nodes, which are close neighbors of preferred parents. It uses RSSI value and rank value for hop distance and for selecting CPS nodes. In addition, ORPL reduces unnecessary retransmissions by using adaptive MAC retransmit limit.

However, the problem is that preferred parents are decided based on the concept of single forwarding scheme but it is not optimal for multipath routing. Also as only highest priority successful parent sends ACK in ORPL, which helps in cooperation among parent nodes and gives low protocol overhead but introduces cooperation errors among parent nodes. However, the best part is ORPL achieves 25% to 30% better PDR than RPL and achieves 10% to 40% lower number of MAC layer retransmissions[8].

C. ORPLx: extension of ORPL

ORPL achieves 50% reduction in MAC layer transmissions but it suffers from a large number of duplicate packets due to ACK failures in ORPL as in ORPL only a highest priority successful node sends ACK after forwarding the packet. Therefore, ORPLx[8] uses new MAC layer extension for improving RPL. In ORPLx's MAC-layer retransmit limit depends upon the factors like a number of nodes in parent set, link success rate and link-quality from source to parent-node.

ORPL provides 50% reduction in MAC layer retransmissions, while ORPLx provides 50% reduction compared to ORPL. Therefore, ORPLx achieves 4-5 times reduction in MAC layer retransmission compared to RPL but its PDR decreases to 98-99% compared to ORPL due to its dependence on the accuracy of the forward link quality estimation[8].

D. CRPL: Cluster-parent based RPL

CRPL – Cluster based RPL[9], achieves low end-to-end cost for nodes, 40% higher PDR than RPL, and 20% more PDR than ORPL. Also improves network reliability and provides low delivery cost.

CPRL shares load by multipath so leads to more energy efficient protocol. CRPL handle the issue of preferred parent via using a top-down approach. Top priority is given to preferred parents (nodes with lower cost to the roots) for packet forwarding, also selecting good inter-link quality parent nodes only. CRPL also suffers by using the local forwarding table, which requires additional memory. In addition, a spatial feature not exploited due to use of priority-based selection[9].

E. Efficient topology construction for RPL over IEEE 802.15.4

This protocol uses the concept of cluster tree as in IEEE 802.15.4 and modifies the cluster tree into the cluster- DAG (cluster – directed acyclic graph). IEEE802.15.4 initially designed and used for single-hop networks. Greedy-algorithm used in integration with IEEE 802.15.4 MAC and MAC mechanisms, which optimized to support multi-hop topologies. The greedy algorithm allows scheduling beacons and active parts of super-frame appropriately while minimizing the bandwidth waste and localized scheduling scheme to allocate collision free slots for beacons and data frames[11]. In multi-hop beacon-enabled wireless networks, IEEE 802.15.4 uses super-frame structure to save energy. The superframe structure allows a node to stay awake during transmission and turn-off radio during inactive state[11].

Cluster structure helps in avoiding overlapping active parts of interfering nodes and multiple paths allowed overcoming single node failures, which effects network performance[11].

Protocol reduces the no. of packet losses and end-to-end delay. Also leads to energy saving by a reduction in a number of transmissions that occur at MAC layer. While the protocol is robust under complex interference patterns but it needs closer integration between IEEE 802.15.4 and RPL for achieving significant results[11].

F. ER-RPL: Energy-Efficient Region-Based RPL

ER-RPL[12] uses the subset of nodes for the discovery of route in comparison to traditional route discovery where all nodes used for route discovery, which results in high energy overhead but using only a subset of nodes allowed to minimize energy consumption. In addition, route discovered is near to optimally reliable.

ER-RPL is hybrid of reactive and proactive protocol that uses region information to help it in communication (P2P) and works in a decentralized way so it can support scalability. It is designed with support for generic-traffic with P2P route discovery and R2R (region-to-region) routing without the support of the route-discovery[12].

PDR increases by 150% and close to P2P RPL with symmetric links thus show the ability of ER-RPL to deliver near-optimal results while using the only subset of nodes for route discovery. Also by using route discovery, which is based on region information, ER-RPL is better in performance than P2P-RPL (with asymmetric links) by 10% because PDR degrades in P2P-RPL due to temporary DODAG is rooted at the source node which is not optimal for traffic under asymmetric links. While ER-RPL makes the temporary-

DODAG rooted at the destination node, which helps to find the best path from source to destination. ER-RPL achieves 60% lesser control overhead when compared to P2P-RPL because destination nodes receive few packets only. In addition, ER-RPL achieves 60-66% energy conservation compared to RPL due to longer routes in RPL and bottleneck (root) as more and more traffic flows through root node. A significant difference from P2P-RPL due to frequency's differences in control messages of ER-RPL and P2P-RPL and number of successfully delivered packets is less in case of P2P-RPL (asymmetric links). The average hop count of P2P paths selected by ER-RPL is closer to P2P-RPL. Control overhead in ER-RPL is 59% - 66% lesser than P2P-RPL in case of both symmetric and asymmetric links. However, it is limited to static networks and assumes that there is enough buffer space available[12].

G. **HECRPL**: Hybrid, Energy-Efficient, and cluster-parent based RPL

HECRPL[13] is a routing protocol aimed at achieving energy-efficiency and reliability simultaneously. It uses topdown approach for selection of optimal-cluster parent set (CPS) which helps in energy conservation and benefits from the path diversity. Coordination among nodes in CPS based on overhearing which helps to reduce numbers of duplicate packets. Residual energy and lossy nature of wireless channel considered for assigning priority between candidate parents in CPS. In addition, HECRPL uses an efficient workload sharing approach, which uses dynamic update approach to updates the priorities of nodes in forwarding sets, which results to achieve fairness and extends the lifetime of the network. It also provides an efficient scheme for lost packets recovery. Transmission power is tuned to improve saving of energy and increase network capacity, which further increases spatial reuse and leads to better routing decision. Also as compared to traditional clustering protocols, which fails in case of failure of cluster heads, it uses multiple paths for robust performance. The author also designed and developed the CRPL but HECRPL differs from CRPL by using new energy-efficient routing metric for optimal CPS selection, which considers energy cost and lossy-nature of wireless networks, refinement of power levels, dynamic update procedure for topology and its maintenance and joint assignment of priorities. CFM (cluster-formation) message is introduced which helps in the propagation of node cost and network topology maintenance in HECRPL. In addition, the distance between nodes estimated using Received Signal Strength Indicator (RSSI) values.

HECRPL have more numbers of alive nodes than RPL as the rate of alive nodes starts from 87% and drops to 50% as traffic flow increases. The decrease in rate is due to more numbers of packets delivered than RPL in the same time of network working, which results in more energy consumption and thus causes some nodes to die, but HECRPL still maintains connectivity. Energy conservation is up to 40% in starting but as traffic flow increases and more data packets delivered, nodes tend to consume more energy. HECRPL effectively delays the time to die for the first node by 46% 25% compared to RPL as traffic flow increases. Performance of HECRPL is 46% - 25% more than RPL as traffic increases. HECRPL shows improvement in reliability up to 85% to 50% compared to RPL but performance decreases as traffic flow increases. HECRPL significantly delays the node's death and provide improved network connectivity and overall better network performance. As initially, PDR of HECRPL is better but on increase of traffic flow PDR decreases for both HECRPL and RPL, but HECRPL still works better than RPL as more number of packets delivered while also maintaining connectivity and significant energy conservation also[13].

The spatial feature is not properly utilized due to timerbased priority scheduling for CPS coordination and efficient load sharing scheme is required to handle congestion. In addition, the author suggested the use of network coding for further improvements for protocol[13].

H. **E2HRC:** Energy-efficient heterogeneous ring clustering routing protocol.

E2HRC[14] routing protocol, uses ring domain as communication topology with each ring having equal area. This protocol tries to solve RPL's energy balance problem by using clustering based algorithm and event-driven cluster head rotation. A newly designed clustering information announcement message and clustering acknowledgment message are used. Ring domain communication routing based on the topology-control model used in the network, which consists of nodes divided into levels based on positions in the network. Also, ring domains divided based on levels. Clustering algorithm used for division of the network into heterogeneous clusters, according to node's residual energy and node's relative position in the cluster. To balance energy consumption and prevent energy hole, a combination of heterogeneous-cluster and cluster head rotation mechanism is used. E2HRC routing algorithm uses backbone routing mechanism, which works by selecting optimal relay node considering optimal-direction angle, the node's residual energy and a minimum number of hops.

E2HRC achieves balance in energy consumption as after routing establishment, nodes dynamically adjust to the transmitting power by the next hop node in their routing information when they have to transmit the data packets. E2HRC efficiently balances the network and decreasing energy consumption of nodes and number of control messages. Due to wider bandwidth in E2HRC, it helps in achieving less packet loss ratio compared to RPL. In addition, as no of nodes increases, E2HRC shows a decrease in packet loss ratio while RPL suffers from an increase in packet loss ratio. Due to optimal direction angle, E2HRC achieves more Packet delivery ratio compared to RPL. In addition, E2HRC reduces the number of control messages compared to RPL as time progresses[14].

Performance of E2HRC can improve by increasing packet delivering ratio as a number of nodes increases because PDR decreases as the number of nodes are increased, but still E2HRC works better than RPL[14].

V. PROPOSED SYSTEM

A heterogeneous ring domain communication topology with equal area in each ring is presented we aim an effort to solve the energy balance problem in original RPL (IPv6 Routing Protocol for Low Power and Lossy Networks). A new clustering algorithm and event-driven cluster head rotation mechanism The clustering information announcement message and clustering acknowledgment message were designed according to RFC and original RPL message structure. An Energy-Efficient Heterogeneous Ring Clustering routing protocol for wireless sensor networks and corresponding routing algorithms and maintenance methods are established implementation for increasing the energy efficiency. As such networks have a short lifetime, in order to more usage and increasing the lifetime, researchers are looking for methods by which they can reduce the energy consumption. Clustering methods and optimization algorithms such as genetic and bee colony algorithm are techniques that can increase the network lifetime.

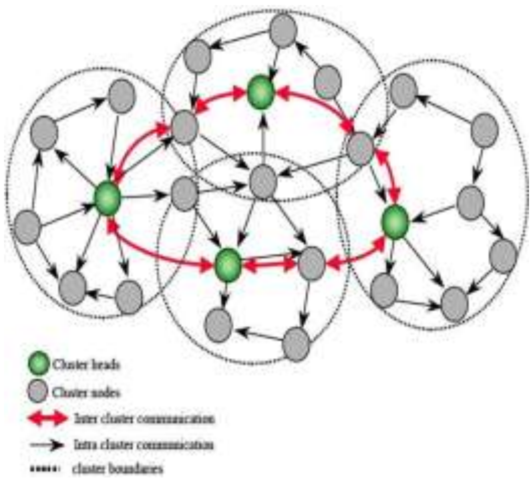


Fig. Proposed Architecture diagram

VI. RESULTS

The number of available nodes in the network	100
The network dimensions	$400 \times 400\ m^2$
Initial energy	0.5 J
MAC	IEEE 802.11
Radio Frequency	200 Db
Radio Interval	$1m^2$
Communicational Range	100 m

The bee combinatory optimization colony algorithm and genetic algorithm parameters are mentioned in the below table

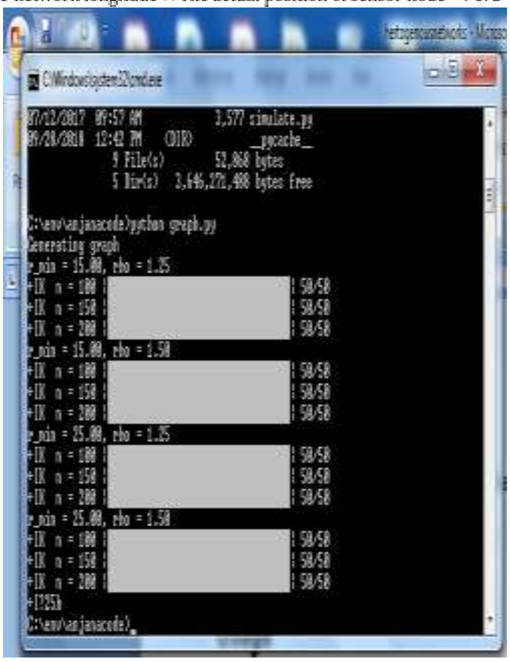
TABLE

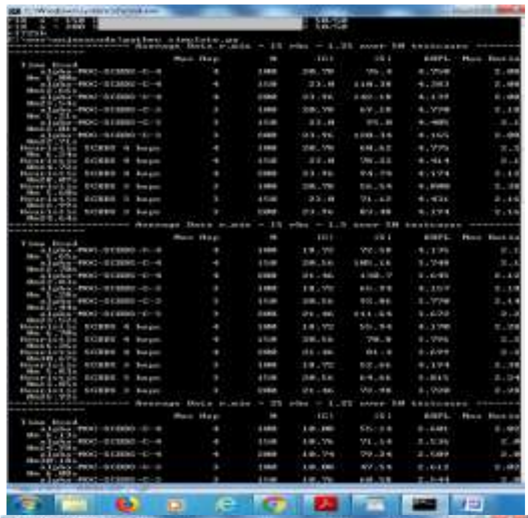
The bee combinatory optimization colony algorithm and genetic algorithm parameters

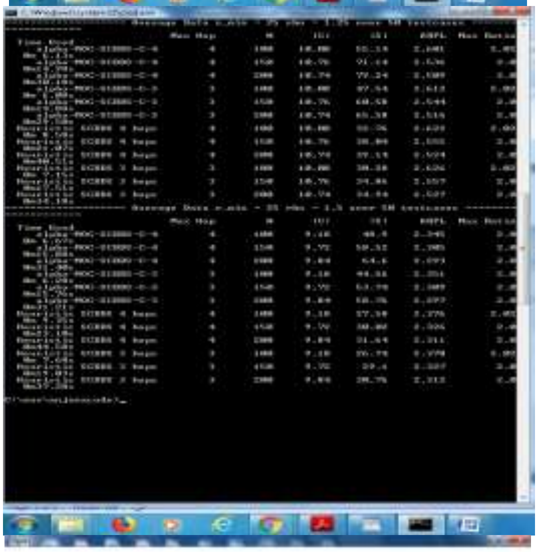
Primary population	60
The number of bees and chromosomes	8
Mutation rate	3
Combination rate	1
The number of combinatory algorithm repetition	100

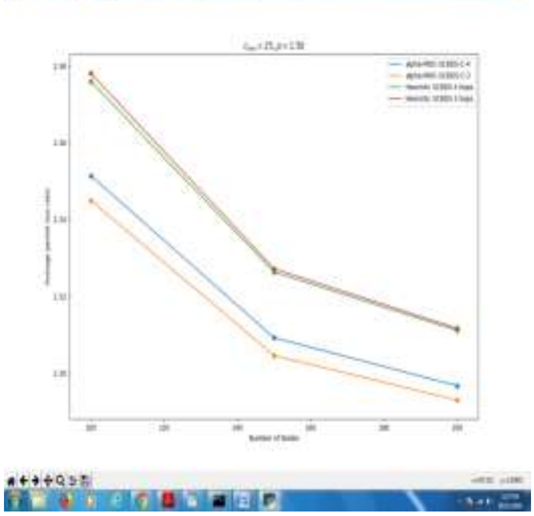
At first, the nodes will be established in the network environment randomly. The difference of the network longitude and the actual position of the sensor node in the network ascertain the received power of nodes in inception which is determined by equation

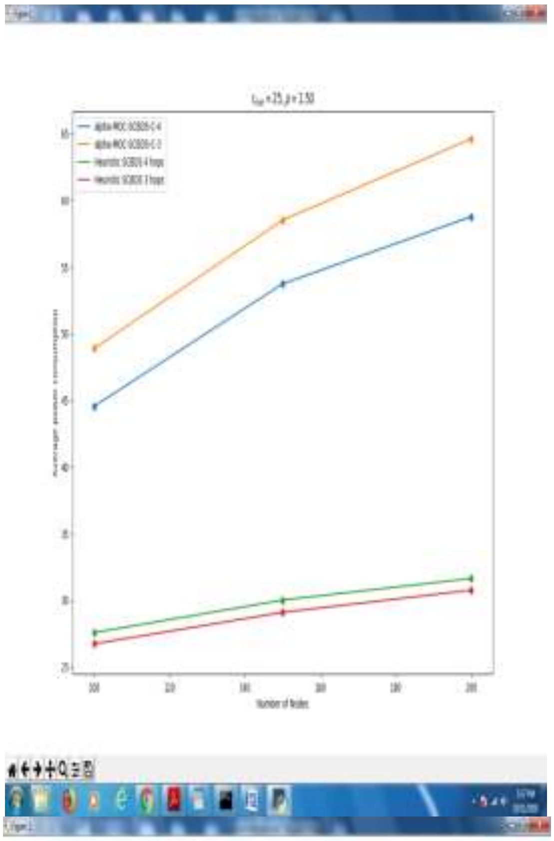
$$\text{The network longitude} \times \text{The actual position of sensor node} < 0.5$$

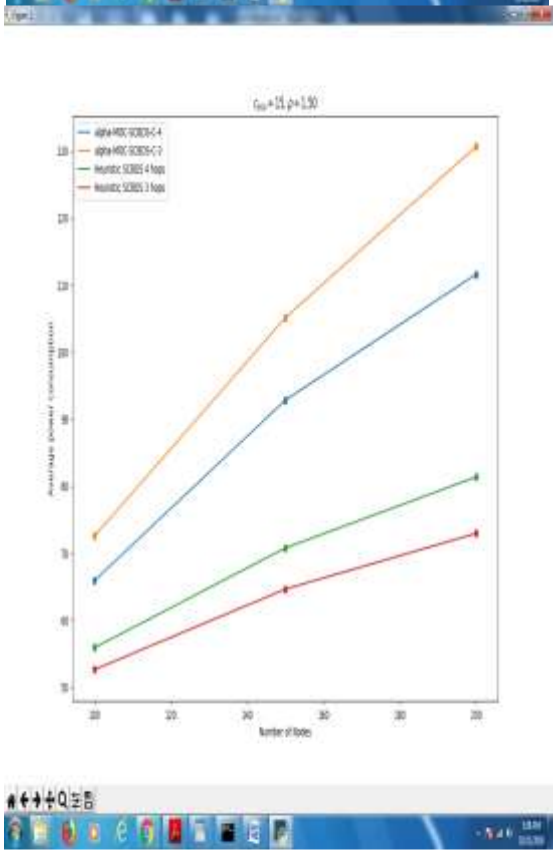


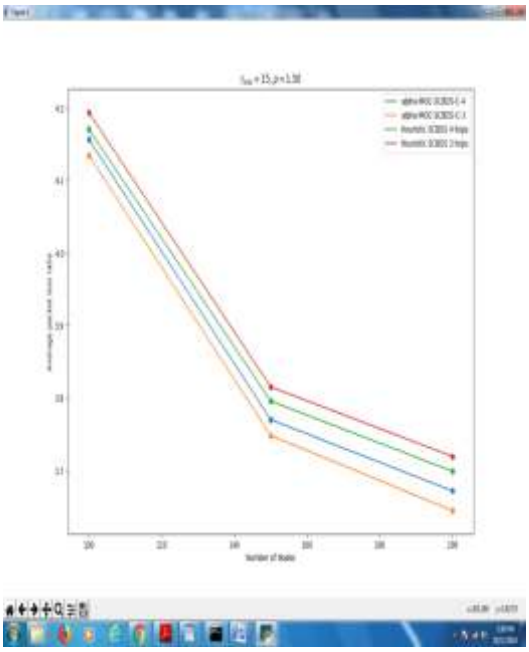












VII. CONCLUSION

This paper focuses on clustering-based algorithm based protocols; these protocols provide better performance than RPL as clustering algorithms provide better performance and work well in lossy and resource-constrained environments. As we discuss in the review, each protocol is good in some areas but still, there are some areas of improvement. We hope we will be successful to provide a review for those working on RPL and this paper helps them in their research. In future, using clustering based algorithms, suggesting an optimized RPL and developed using new or improved routing techniques.We established a heterogeneous ring communication topology and implement an ant bee colony algorithm to find the best fitness path , proposed a related clustering algorithm for this topology, and built the E2HRC routing protocol to improve original RPL performance in this study. The proposed method yields better average energy consumption and overall performance than RPL while balancing the energy consumption of the whole wireless sensor network. We also designed a messaging structure for clustering and routing and verified that both protocols are efficient and effective.

REFERENCES

[1]. E2HRC:An Energy-Efficient Heterogeneous RingClusteringRouting Protocol forWireless Sensor NetworksWENBO ZHANG, LING LI, GUANGJIE HAN1, (Member, IEEE), AND LINCONG ZHANG

[2]. NileshKumar,MamtaKatiyar“AnEnergy Efficiency Routing Protocol for Improving Lifetime of Wide Area Wireless Sensor Networks: A Review” International Journal of Engineering Trends and Technology (IJETT) – Volume 11 Number 2 - May 2014

[3]. Hyunjo Lee, Miyoung Jang, and Jae-Woo Chang, “A New Energy-Efficient Cluster-Based Routing Protocol Using a Representative Path in Wireless Sensor Networks” International Journal of Distributed Sensor Networks Volume 2014 (2014), Article ID 527928

[4]. Mahmood Ali and Sai Kumar Ravula” Real –time support and energy efficiency in wireless sensor networks.

[5]. Kemal Akkaya and Mohamed Younis “A Survey on Routing Protocols for Wireless Sensor Networks”

[6]. M. Aslam, N. Javaid, A. Rahim, U. Nazir, A. Bibi, Z. A. Khan “Survey of extended LEACH – based clustering routing protocols for wireless sensor network” IEEE transaction on Antennas and propagation ,vol 50 No 5 May 2012.

[7]. Jamal N. Al-Karaki Ahmed E. Kamal ” Routing Techniques in Wireless Sensor Networks: ASurvey∗”

[8]. Sabarish B A, Guru Moorthy S M, Dhivya M A, Sakthi Naveen K, Vaishnavi S “A survey on clustering protocols in Wireless Sensor Networks” International journal of advances in computing and information technology.

[9]. M.BaniYassein, A.Al-zou’bi, Y.Khaayseh W.Mardini.“ImprovementofLEACHprotocol of Wireless sensor network".Thiemo Voigt, Adam Dunkels, Juan Alonso “Solar-awareClustering in Wireless Sensor Networks”

[10]. Tao, L zhu ,QXzhang l. “An improvement for Leach algorithm in wireless sensor network ,proc 5th IEEEconfIndustElectrappl

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