Performance Enhancement of Wireless Sensor Networks Availing Trust and Threshold Factors Mechanism

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***Abstract* - The domain of Wireless Sensor Network (WSNs) constitutes a very active research field and Energy-Efficient Nodes have evolved core setback and as a result, users are facing significant energy conservation issues. Predominately Researchers are trying to resolve energy problems with the help of Routing Protocols using various techniques and mechanisms. If one protocol is higher in energy dissipation, it may perhaps have more delivery delay or its algorithm may be multifaceted. On the other hand, if a protocol offers a smaller amount of delay or low complexity in algorithm then it may be a lesser amount of energy-efficient. Energy consuming due to numerous variables such as the number of nodes, the distance of the network from source to destination, the position of the base station, the preliminary system energy, etc. The motivation of this Research started while working with Network simulator for performance enhancement taking into consideration Energy efficiency parameter and found various challenges in respect to efficient node energy utilization, network balancing with optimum energy consumption and extending the lifetime of a network in WSNs. In this paper, we use the Network Simulator (NS2) as a simulation modus operandi to investigate using Low-energy adaptive clustering hierarchy (LEACH) protocol to augment the performance of nodes as and when wherever the network nodes function on restricted energy consumption. The main objective is to utilize minimum energy while transmitting and receiving data with minimum packet loss. The proposed work focus on the objective of improving the source to destination communication energy efficiency utilizing with single-hop technique. To implement the methodology Cluster-Based Routing Protocols named LEACH (hierarchical protocol) is availed for managing the location and energy of the communication. The experimental result analysis is performed on the parameters like Node count, Throughput, Packet Delivery Ratio (PDR) and Energy.**

***keywords* - Wireless Sensor Network, Energy-Efficient Node, Routing Protocols, Network Simulator, LEACH protocol, single-hop technique, Cluster-Based Routing Protocols, Node count, Throughput, Packet Delivery Ratio, Energy.**

I. INTRODUCTION

Energy utilization affects Wireless Sensor Networks (WSN) life span and may cause network deficiency. Communication distance connecting the sensor nodes and base station affects the association of energy. The more communication detachment among two nodes the more energy consumed. The clustering technique is used to reduce energy consumption in wireless data transmission. Determining the best possible amount of clusters in WSNs gives superior enhancement in system scalability, increases energy competence, and enhances network lifetime in the network. [1] Sensors perform necessary simple computations and share the in sequence with Base Station. The main objective of a wireless sensor network is to detect an event and send information to other nodes consistently. In WSNs, sensor nodes have limited energy communication bandwidth and storage space. Due to limited life, it requires a proficient supply of utilization. The sensor nodes are grouped into an assortment of small single sets called clusters. The clustering method provides abridged communication overheads, and effective resource allocations thus increase the overall lifetime of the network. Shaping the best possible number of clusters in WSNs offers greater enhancement in terms of energy efficiency, system scalability, network lifetime, and latency. Nodes in sensor networks encompass limited storage, computational and energy resources, these limitations place a limit on the types of deployable routing mechanisms[2]. Energy-efficient routing is one of the main mechanisms probable to decrease the cost of communication in a wireless networking environment as there are no secured connections between nodes.[3]. Using a long route composed of many sensor nodes can considerably increase the network delay. At a similar time, always choosing the direct path force result in the lowest power utilization and lowest network delay. These routing mechanisms above all change in terms of routing objectives and routing techniques, where the techniques are mainly influenced by the network characteristics[4]. The design of energy-efficient scheme is a major challenge especially in the domain of routing, which is one of the key functions of the WSNs[5]. Some of the most Common Factors affecting the Routing Protocols Design are Node Deployment, Node/Link Heterogeneity, Data Reporting Model, Energy Consumption without Losing Accuracy, Scalability, Network Dynamics, Fault Tolerance, Connectivity, Transmission Media, Coverage, Quality of Service, Data Aggregation [7]. Routing protocol for invariably uses Clustering Technique for efficient Energy management.

I.1 WSNs Clustering: Clustering is one of the key methods for extend the network lifetime in wireless sensor networks (WSNs). It involves grouping of sensor nodes into clusters and electing cluster heads (CHs) for all the clusters.

The advantages of clustering are listed as follows:

- It provides bandwidth reuse, thus can increase the system capacity within a cluster.
- All the normal nodes send their data to the CHs so that energy saving is achieved.
- Clustering provides efficient resource allocation and thus helps in better designing of power control. Clustering facilitates data aggression/data fusion[1].

There are various Cluster Formation Techniques like Single hop formation, Multi-hop formation, Probability Based, Non-Probability Based, Partition Clustering Techniques, Hierarchical Clustering and Mixture of Distribution.
Performance Enhancement using Clustering in WSNs can be achieved by managing certain parameters like Delay, Throughput, Hop Count, Overhead, Packet Ratio, Energy, Mobility, Network Area, Number Of Nodes, Time, Initial Energy Of Nodes, Data Packet Size and Transmission Radius. Among these effective Energy Efficiency management is a major challenge. To manage it and for performance enhancement of WSN the most commonly availed clustering protocol is Hierarchical Clustering Protocol, these are LEACH, LEACH-C and other variants of LEACH[1].

I.2 LEACH PROTOCOL:

It is an adaptive clustering routing protocol. The main goals of LEACH are: increasing network lifetime, low network energy consumption, reducing the number of communication messages by data aggregation. This protocol facilitates the nodes with more residual energy have more chances to be selected as a cluster head. In array to expand the lifetime of the whole sensor network, energy load has to be consistently disseminated among all sensor nodes so that the energy at a sole sensor node or a tiny set of sensor nodes will not be exhausted out. The LEACH protocol forms clusters in the sensor networks and randomly selects the Cluster- heads for each cluster. Non-cluster-head nodes sense the data and broadcast to the cluster-heads. The cluster-heads aggregate the received data and then forward the data to the base station[6].

II. Literature Review :

The Research Work findings are based on the following given Literature Reviews.
Koriem et al. In this paper, discusses about the CRP (Circles Routing Protocol) and has been presented to enhance the performance of WSNs, where the network nodes operate on limited battery energy. To evaluate the performance of the proposed routing protocol, the comparison of its performance results are done with those obtained from LEACH and PEGASIS routing protocols. Based on these comparisons, it was found that the results of the developed protocol are more efficient in terms of Network Life Time, Energy Consumption, Throughput, Transmission Delay and Average Delivery Ration. This clustering technique leads to minimize the communication process between neighboring nodes, and the computation process on the network nodes.[8]
Akhtar et al. In this paper reviews and provides an overview of prominent cluster-based energy-efficient routing protocols based on some primary performance metrics. This study concludes that there is not any single protocol that can perform excellently considering all metrics. [9]
Mehta et al.The Authors in this paper provide a taxonomy of hierarchical routing protocols and look to envision a hybrid hierarchical routing protocol that may embed characteristics of intelligent routing protocols. The authors have proposed to use swarm intelligence based concepts in cluster formation and their hierarchical routing to enhance the scalability, adaptability, and robustness of hierarchical routing protocols.[10]
V & Ranjendra et al. The Authors proposed energy-efficient routing techniques called reliable minimum energy cost routing (RMECR) and comparing with reliable minimum energy routing (RMER) which are used by the nodes in the most efficient manner. The proposed RMECR protocol is also used to decrease the cost of communication in a wireless networking environment.[3]
Krishna et al.The Authors discussed a comparison of two routing protocols for wireless sensor networks with different simulation times. Also, AODV over WSN is simulated with different topology changes. With the results of the trace graph, it was concluded that in the case of flooding, the throughput of delivered packets is quite less than the throughput in the case of directed diffusion. Since the energy of the nodes is a constraint in wireless sensor networks, so a fixed amount of energy is given to the network in both cases.[4]
Ambekari et al. The Authors discuss to develop an energy-efficient system using clustering. Determining an optimal amount of clusters in WSNs gives a superior improvement in system scalability, increases energy competence, and enhances network life span, in the network. For a large WSN lifetime of network depends on the cluster distance and amount of hops. The energy cost of a network is directly proportional to the number of clusters. The clustering technique balances the load distribution in a network and reduces traffic transmission.[1]
Oladimeji et. al. This paper proposes a novel Heuristic Algorithm for Clustering Hierarchy (HACH), which successively performs a selection of inactive nodes and cluster head nodes at every round. Inactive node selection employs a stochastic sleep scheduling mechanism to determine the selection of nodes that can be put into sleep mode without adversely affecting network coverage. The proposed algorithm is evaluated via simulation experiments and compared with some existing algorithms.[5]
Reddy et al. In this paper, a well-known protocol in wireless sensor networks called LEACH is discussed. LEACH is the first low energy protocol introduced in WSN which saves energy and increases the life span of the sensor networks. With the number of advantages of the LEACH protocol, it also comes with some drawbacks. To overcome those drawbacks and make LEACH more efficient many descendants of LEACH protocol are introduced and some of them like E-LEACH, LEACH- B, HEED, LEACH-F, TL-LEACH, MULTI-HOP LEACH, LEACH-C, LEACH-M, I-LEACH, CELL- LEACH, and V-LEACH are described in this paper that how these protocols overcome the disadvantage of the LEACH protocol and make the sensor networks more efficient.[6]

More et al. In this paper, discuss various coverage optimization protocols. These protocols are largely classified as clustering and distributed protocols. Further, these protocols are classified based on the type of sensing model used, node location information, and the mechanism used to determine neighboring node information In this paper, the authors review the key coverage optimization protocols and present open research issues related to energy-efficient coverage.[11]
Alharthi et al. The hybrid threshold sensitive and two-level heterogeneous LEACH (HT2HL) is proposed in this paper. The performance of the proposed protocol outperforms in the simulation. The drawbacks in LEACH are dealt with in our work. For instance, SNs can communicate directly with the BS if all CHs are far from them and they adjust their transmission power based on the distance from CHs and the BS. Thresholds are incorporated to reduce the number of transmissions that conserves energy.[12]
Panigrahi et al. This paper aims to provide a trust management scheme to address the packet drop attack or black hole attack made by a compromised sensor node inside WSNs. Along with the security feature against the above attack, it is implemented by DIJKSTRA shortest path algorithm to regain the speed efficiency which may have been degraded due to trust computation in various phases of the routing inside and outside of clusters in the network. The proposed model is confined up to 100 nodes. In the future, the above can experiment for a large network consisting of more than 100 nodes. With the exclusion of the above cases, the model gives efficient results in terms of various parameters of routing as well as security in comparison to that of the LEACH protocol.[13]
Various Research Gaps were identified from the above Literature review and performance enhancement of WSNs with the focus on Energy efficiency was considered as a key challenge of the Research Work.

III. Problem Formulation: Increasing the lifetime of sensors in the network by decreasing their energy consumption has become one of the main challenges of using WSNs in practical applications. Increasing efforts to minimize energy consumption via new algorithms and techniques in different layers of the WSN, including the hardware layer (i.e., sensing, processing, transmission), network layer (i.e., protocols, routing) and application layer Sensors (nodes) in such networks are responsible for four major tasks: data aggregation, sending and receiving data, and in-network data processing. Since routing is a significant and costly task in WSNs, routing protocols should be energy efficient to increase the network lifetime.

IV. Proposed Methodology: The proposed work focus on the objective of improving the source to destination communication energy efficiency utilizing with single hop technique. To implement the methodology Cluster Based Routing Protocols named LEACH (hierarchical protocol) is availed for managing the location and energy of the communication. The result analysis is performed on the parameters like Number of Nodes, Throughput, Packet Delivery Ratio and Energy.

- The methodology is implemented on different node count scenario like 15, 25, 35, 50 etc.
- Based on individual count scenario the Communication between source and destination node is initiated and the source node status is updated from Static to Dynamic to achieve robustness in short and long distance data transfer as well as to avoid packet loss.
- An intermediate node is allocated a responsibility of CENTER NODE that acts as mediator between Source and destination node. To qualify as a Center Node it has to satisfy two characteristics criteria of Clustering Technique as the nature of node is random :
    - Trust factor: It provides secure routing, while preserving the essential functionalities of the protocol by making a cluster. The Center node must be of the same class of data that is of the same cluster.
    - Thresholding Factor: The Center node should fall within same range of the same cluster.
- Once the allocated Center Node reaches the boundary of the cluster, to continue the data transfer another node selected as Center Node based for which the Source node broadcast the message to all the nodes based on the above Center Node Characteristics criteria in order to qualify as Center Node. The responsibility of Center Node is transferred from previous assigned Center node to the currently qualified Center Node. After this the previous Center node functions as ordinary Node.
- The above process continues till the data transfer communication from source to destination is completed.
  The implementation of the above proposed methodology is performed using a Network Simulator.

V. Implementation:

The implementation was performed based on the above Proposed Methodology as specified in the below Steps.
Step 1: Scripting the mechanism in Network Simulator (NS2) and generating the scripts.
Step 2 : Executing the script in Network Simulator (NS2) and visualize the methodology implementation like applied Protocol behaviour, packet flow between source and destination, searching of centre node, Node movement establishment, packet drops according to the node scenario till the completion of communication between source to destination node in wireless networks.
Firstly to visualise step 2 a scenario of 25 nodes is created that is displayed in Figure 1.

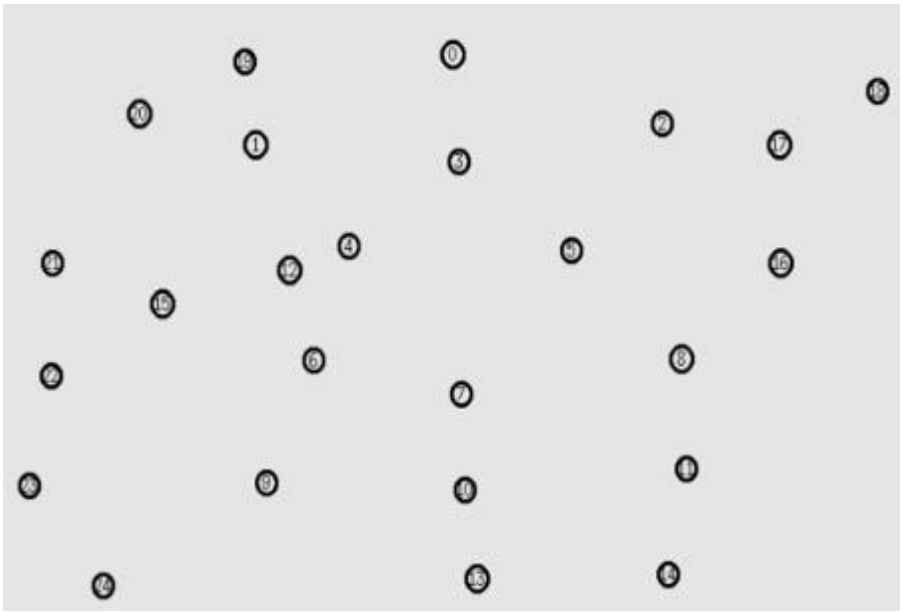

Figure 1: 25 Node Scenarios

Secondly there is a data transfer Communication initiates between source and destination node that is shown in Figure 2.

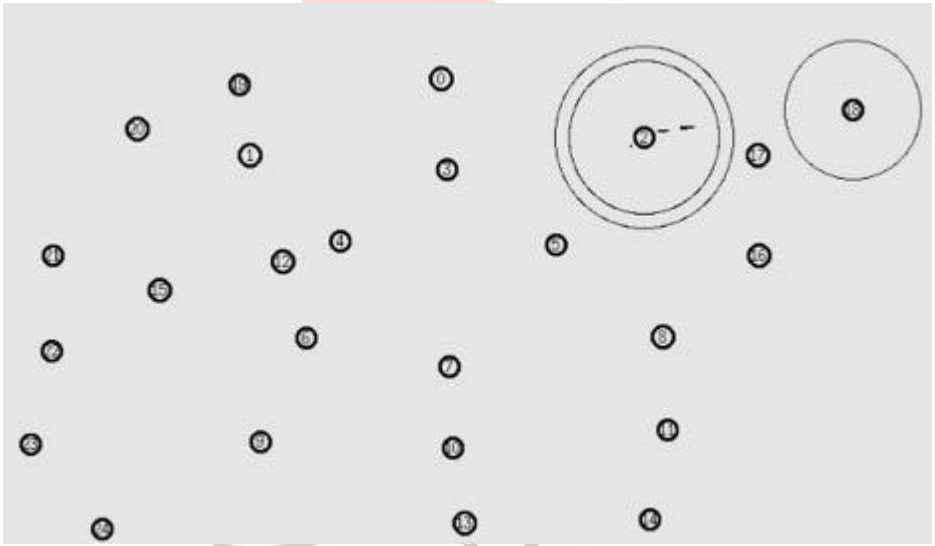

Figure 2: Source to Destination Data Transfer Initiation

Thirdly the proposed mechanism of searching a Center Node for effective data Transfer and energy Saving to avoid data packet loss as discusssed in Proposed Methodology is shown in Figure 3. As mentioned earlier to qualify as a Center Node it satisfies two characteristics criteria of Clustering Technique namely thresholding and Trust Mechanism.

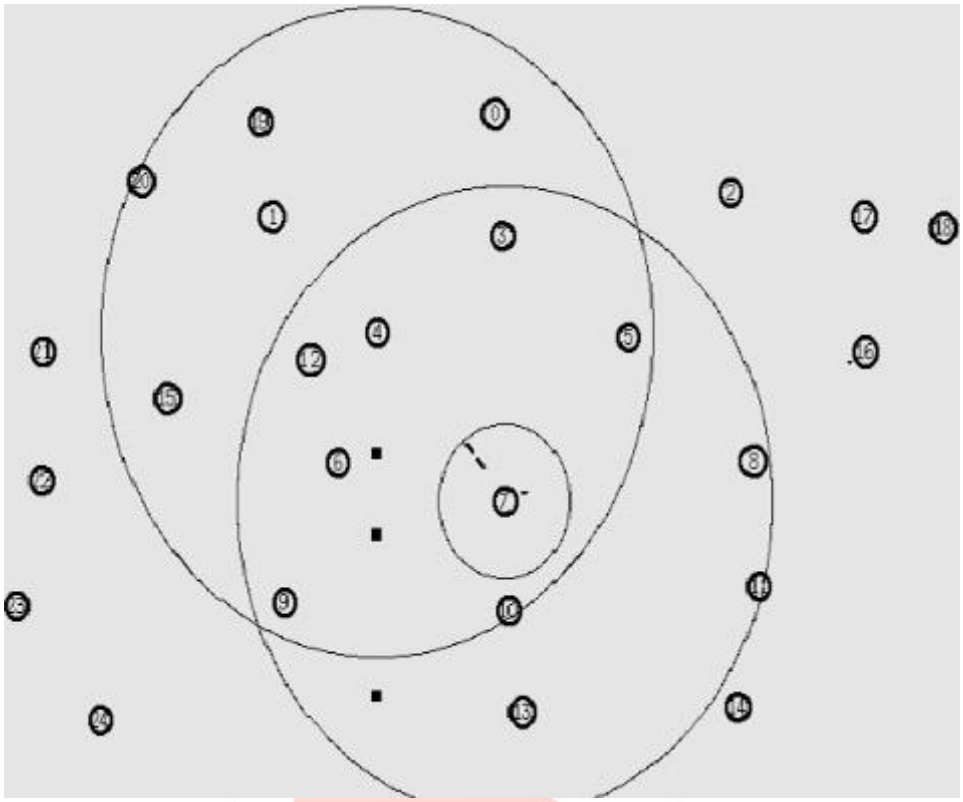

Figure 3: Selection of Center node base on Trust and Thresholding Mechanism

Fourthly the data transmission flow starts from selected Center node to Destination node as shown in Figure 4.

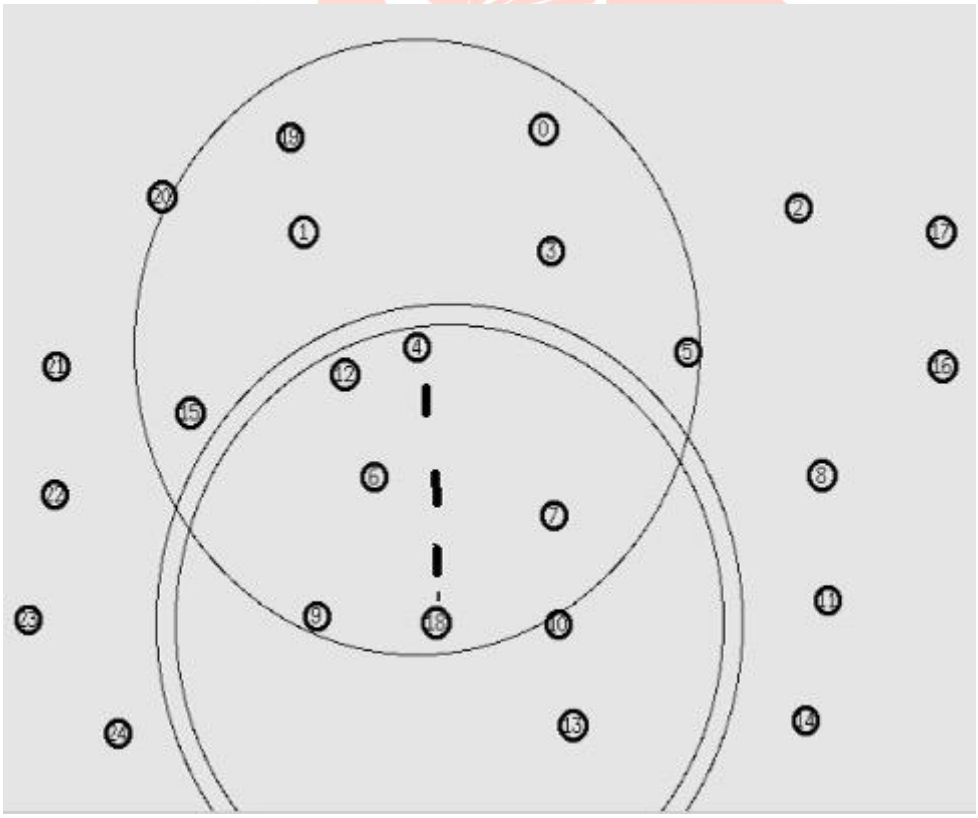

Figure 4: Data Transfer from selected Center Node to Destination node.

Fifthly further if there is any packet loss during data transmission the Source Node checks for another Centre Node based on Trust and Thresholding Mechanism.Once another Centre Node is appointed the previous Center Node functions as Ordinary Node.

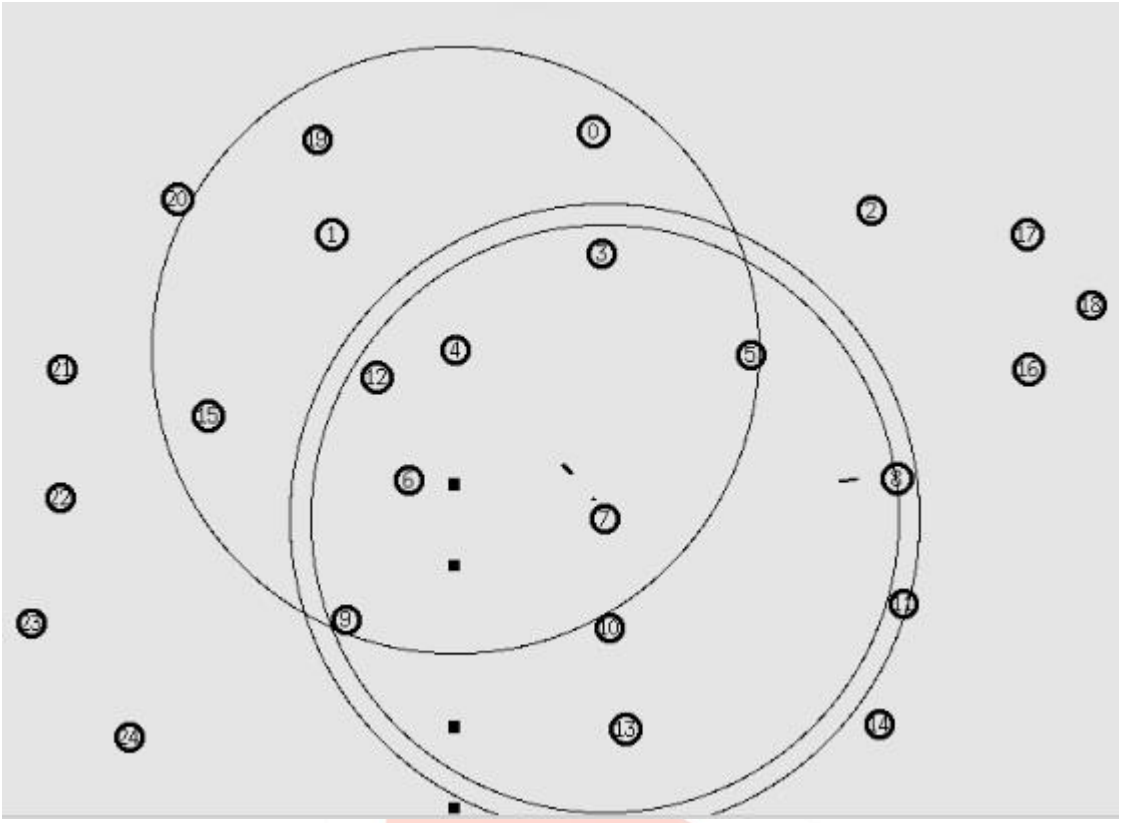

Figure 5: Selection of new Center node base on Trust and Thresholding Mechanism

The above process continues till the Data Transfer is completed from Source to Destination.

Step 3: Obtaining the results of the executed script.
The proposed methodology was implemented on 15, 25, 35, 50, 100 count of nodes to obtain Parameters values obtained availing Proposed Methodology and to justify the proposed mechanism as shown in Table 1.

Table 1: Parameters values obtained availing Proposed Methodology

Number of nodes	Packet Delivery Ratio (%)	Throughput (KBPS)	Energy(J)
15	0.9954	305.26	159.654
25	0.9955	305.36	236.627
35	0.9956	305.46	313.819
50	0.9958	679.82	428.805
100	0.9959	679.92	769.628

Step 4: Analysing the values obtained in the results of the applied parameters in the script.
The Parameters values obtained availing Proposed Methodology were analysed in form of graphical representation considering Number of Nodes in X-Axis in all and the other parameters Y-Axis individually.

Firstly the Figure 6 shows the Packet delivery ratio with different number of nodes through linear increase predominantly with the increase number of nodes count.

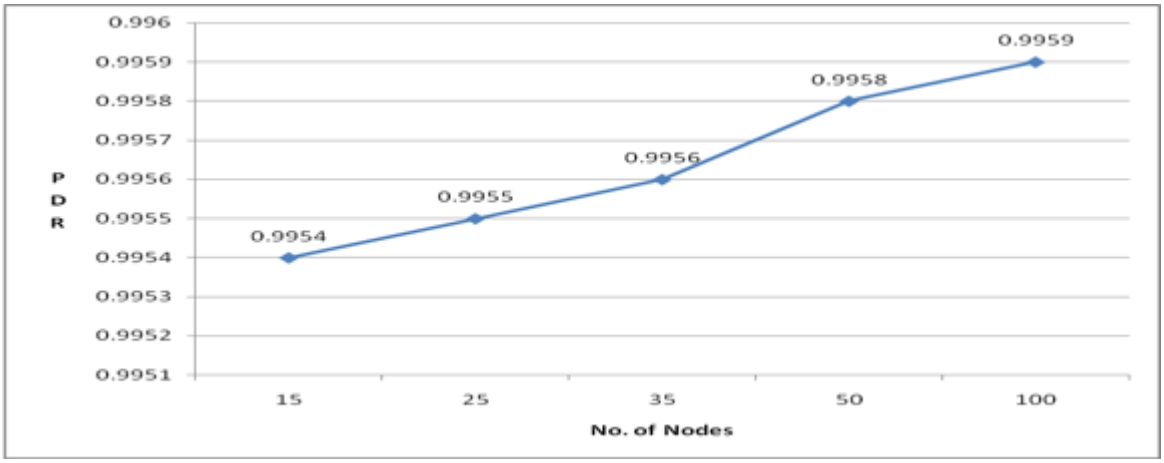

Figure 6: Number of Nodes Vs Packet Delivery Ratio

Secondly the Figure 7 shows the Throughput with different number of nodes where it was observed values were stable for 15, 25 and 35 number of nodes and then there was linear increase predominantly with the increase number of nodes count for 50 and further it became stable for 100 count of nodes.

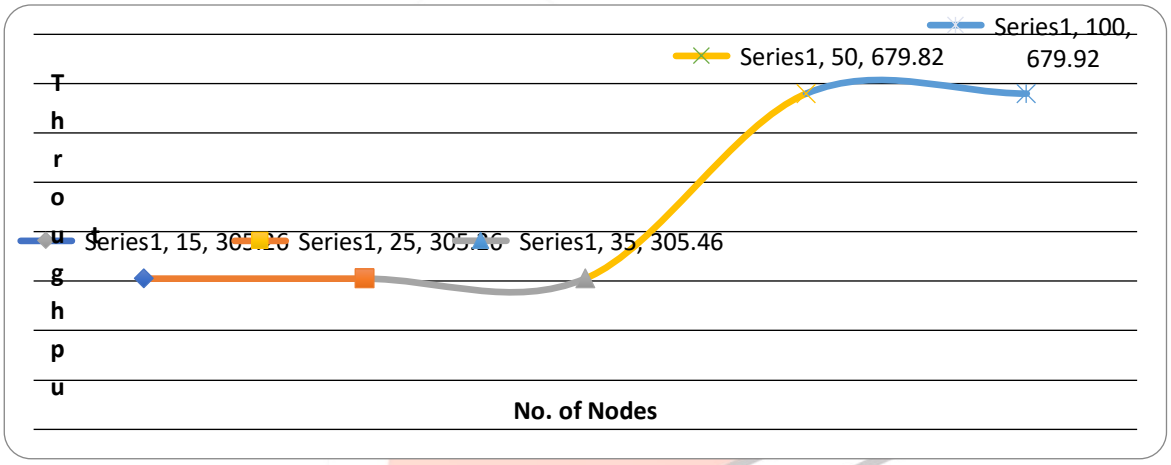

Figure 7: Number of Nodes Vs Throughput

Thirdly the Figure 8 shows the Energy with different number of nodes through linear increase predominantly with the increase number of nodes count.

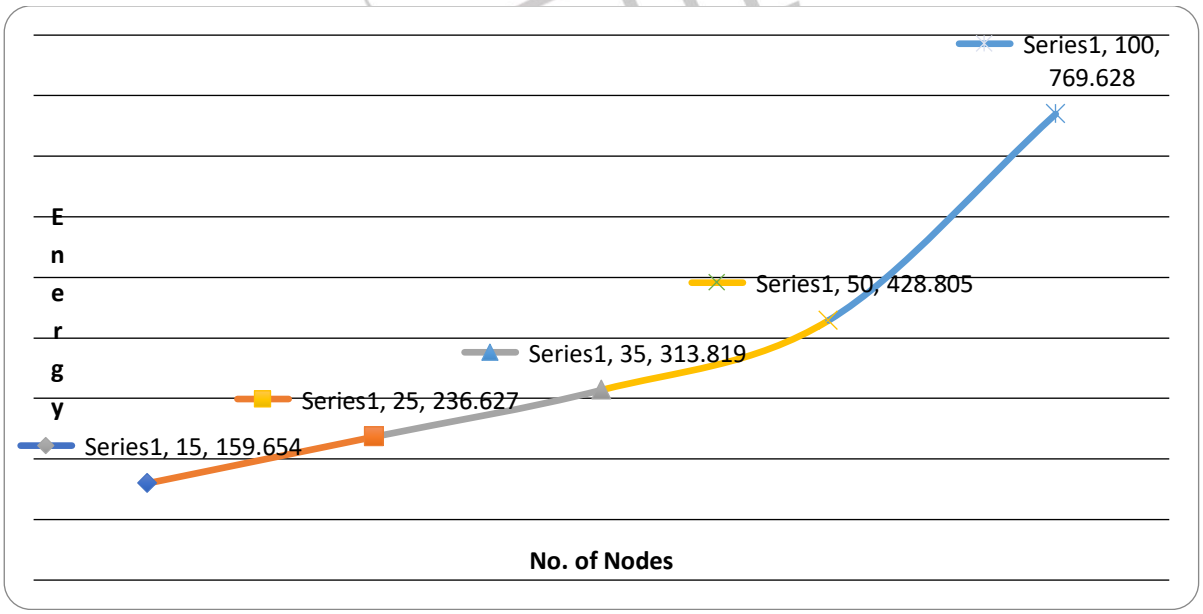

Figure 8: Number of Nodes Vs Energy

The considered parameter values that were obtained from the executed script makes it evident that by using the Proposed Methodology and Mechanism there will be a remarkable impact on energy efficiency that will enhance the performance of the WSNs. Further it is observed that at the same time there is no other loss in terms of efficiency with respect to time and as well as data loss.

VI. Conclusion

In this paper, the work is focused on the optimization of the node energy based on optimal clustering in wireless sensor networks using Trust factor and Thresholding Factor. The implementation of the above-proposed methodology is performed using a Network Simulator (NS2). Based on individual count scenario the communication between a source and the destination node is initiated and the source node status is updated from Static to Dynamic to achieve robustness in short and long-distance data transfer as well as to avoid packet loss. An intermediate node is allocated the responsibility of the center node that acts as a mediator between the Source and destination node. To qualify as a Center Node it has to satisfy two characteristics criteria of the Clustering Technique as the nature of the node is random. The above process continues until the data transfer communication from source to destination is completed. However the centre node becomes a normal active node and behaves as Ordinary Node. It can even be stated as by using this mechanism there will be increase in energy efficient that lead to Performance Enhancement in WSNs.

VII. Future Enhancement

In the future the plan is to extend the proposed work with larger number of nodes with extended area of the network. To enhance the energy efficiency with additional parameters using multi-hop techniques taking into consideration busy nodes and drive the data for more energy efficiency using a non-busy path. That will finally lead to improvisation of the efficiency of nodes in Wireless Sensor Networks.

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