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CONFIGURATION OF THE WIRELESS SENSOR NODES BASED ON SWARM OPTIMIZATION AND GENETIC ALGORITHM IN A HETEROGENEOUS NODE ENVIRONMENT USING NS2

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Abstract: with the enhancement of number of devices in existing wireless communication networks, which demands for the upgrading of the number of serving devices such as nodes for the packet delivery efficiently to deal with the enhanced coverage, capacity and implementation cost using Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) as an suitable building block of network in the wireless sensor network. The major issue with the wireless networks in the limited area networks under supervision will suffer with the multiple interference in the coverage area. The issues of the interfrence are incresed in the non rural areas due to higher rate of population and maximum number of user in the same vicinity. For the addressing of the challegeing issues in the wireless communication domain and certain modification to the exisiting homeogenous and heterogenous network is proposed for the improvement in terms of overall network throughput, capacity of the entire network for various nodes and variable ranges. In this present research work is carried out with demonstration of different nodes for the self organizationn criteria for existing nodes deployed with two different algorithm such as gentic algorithm and particle swarm algorithm for the self allignment of the wirelss sensor network.Finally, simulated results in NS2 and numerical values are conducted and validated to various data packets.
Keywords: Wireless Sensor Network, NS2, Genetic Algorithm, Optimization, network nodes,

1. Introduction

Sensor networks that are deployed utilizing a wireless protocol for network communication are known as Wireless Sensor Networks (WSNs). Network architecture, as well as Sensor nodes, are the two components of a conventional wireless sensor network. Processing Unit, Power Supply, Communication System, and Sensor are the four principal elements of the Sensor node that are present in WSN. [2]

The conversion of data collected from the physical world by the sensor is converted into digital form by an Analog to digital converter. Advanced data processing as well as the modification is been carried out by the primary processing unit i.e., a microcontroller or a microprocessor. A radio system typically a short-range radio is used in a communication system to transmit as well as receive data. Compact battery such as the CR-2032 is required to charge the entire system as all the parts are low-power gadgets. Communication, processing, as well as storage units along with sensing component, is some of the features of the Sensor Node. Along with these features and enhancements, a Sensor Node is in charge of gathering information from the real world and is also responsible for network analysis, data correlation, as well as a fusion of data from other sensors with its information.[3]

2. Genetic algorithm:

The majority of optimization algorithms are adaptive heuristic search algorithms known as genetic algorithms (GAs). Natural selection as well as genetics is the basis of genetic algorithms. This algorithm is smart and uses random search as well as past data to concentrate on areas with enhanced performance in the design space. Genetic algorithm is frequently employed to develop excellent solutions for efficiency as well as search-related issues. [4]

Natural selection as well as genetics is the basis of genetic algorithms. By developing generations repeatedly, these algorithms extract the research problem as a group of people and then try to determine the healthiest person. Genetic algorithm is frequently employed to develop excellent solutions for efficiency as well as search-related issues. A fitness function evaluates quality rules by providing a quantitative representation of how well it can adapt to its environment. Beginning with a randomly generated model, the process starts. Selection, crossover, as well as mutation, are the three fundamental genetic processes that are successively adapted to every human with varying probabilities.[5]

2.1Network Architecture

The interconnection of several sensor nodes plays a vital role and is connected over a wide area to collectively monitor external conditions. In WSN, a sensor node communicates with the base station as well as with other sensor nodes with the help of wireless communication. The sensor nodes interact with each other to complete the task upon receiving commands from the base station. Further, the sensor nodes deliver the required information to the base station after receiving the required information. A base station can communicate with other networks over the internet.[6]

2.2 Network Simulator 2 (NS 2):

Network Simulator is an event-driven simulation tool and is also referred to as NS2. The network simulator exhibits many advantages in exploring the complex nature of communication networks. With the help of NS2, it is possible to simulate wired and wireless network functions along with protocols such as routing algorithms, TCP, as well as UDP. Users can also design these network protocols as well as simulate them using NS2. NS2 has experienced significant growth in recognition among networking researchers since 1989 due to its adaptability as well as a modular design.[7]

For modelling multiple wireless protocols operating at various layers of the communication networks model, the Network Simlator-2 is been widely used. A mathematical study that relies on the IEEE publication database which is a popular portal for publishing research articles in the field of communication networks is illustrated in this section to quantify its significance. In order to examine several research publications that have dealt with wireless networks that employ NS-2 or any other network simulation platform, search queries based on advanced command are employed in the existing system. Mainly research papers, journals, as well as magazines, are considered for this work. It is significant to notice that data for journals as well as magazines are presented as a specific group in the IEEE search engine results.[8]

Licensing policies of simulators are shown in table 1 and are outlined as either closed source (Proprietary), free and open source, or only open source with some limitations. There exist only a few simulators that are not recognized because of the insufficient information provided. [9]

3. Algorithm and proposed methodology

Cell systems often include femtocell access points (FAPs) to enhance life as well as network coverage [1]. FAPs are simple solutions to effectively offload the macrocell arrangement and thereby enable higher data rates for internal users. The efficiency of this entire development process is demonstrated by statistical analysis and thus exhibits rapid as well as thick femtocell transmitting especially in urban areas. The problems with data transmission arise from the random deployment of adjacent Access Points (APs) in the same geographic area as the macrocell. Furthermore, inefficient femtocell operations consume energy and as a result, dynamic solutions are necessary to efficiently plan, supervise, as well as improve femtocell network connections. [10]

Adaptively enabling open access is a specific solution to save the overall cost. However, the thick as well as random transmitting of femtocells might cause low EE, especially in conditions with a mild load. Additionally, problematic femtocell broadcasts obstruct the control as well as communication routes. The femtocell behavior in reference to client proximity as well as cell load can be changed by adjusting the instruments which further results in energy savings and enhanced communication. The activation or deactivation of dynamic cell devices can enhance the system's performance by allowing adjacent APs to self-deactivate without affecting adjacent end clients.

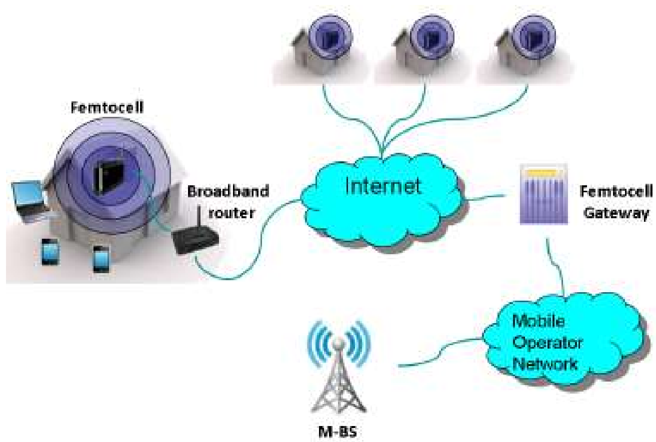

Fig. 1. General model of the Femtocell Architecture

The network's nodes include many low-power nodes which facilitate future mobile systems to globally provide internet service remotely in an inexpensive way. Nowadays, Femtocells have gained the attention of mechanical as well as analytic networks where all the various specialized setups available are moveable such as radio remote headers, transactions, picocells, as well as scattered reception devices. Approximately 60% of traffic is generated inside portable devices according to the analysis [19]. Cell systems make use of this development in application with FAPs. As illustrated in Fig. 1, these access points provide radio integration via a specific remote technology and also being connected to a cell administrator's backhaul system via a broadband cable connection.[11]

The flow chart of the proposed method of configuring the WSNs using swarm optimizing and the genetic algorithm in a heterogeneous environment is shown below in Figure 2. The algorithm starts with the initialization of the sensor nodes. In the initialization, sensor nodes are initialized with the predefined values and positioned in the network. After initialization, the number of heterogeneous nodes present in the network is obtained. The heterogeneous nodes obtained are in the range of 10 to 30 in the network. Next, an appropriate intelligent deployment technology is chosen, i.e., either genetic algorithm or particle swarm optimization is selected. Based on the selected method of deployment and the implementation of the optimization method, the placement of the heterogeneous node is decided and is placed. Finally, suitable configurations will be selected for the heterogeneous nodes.

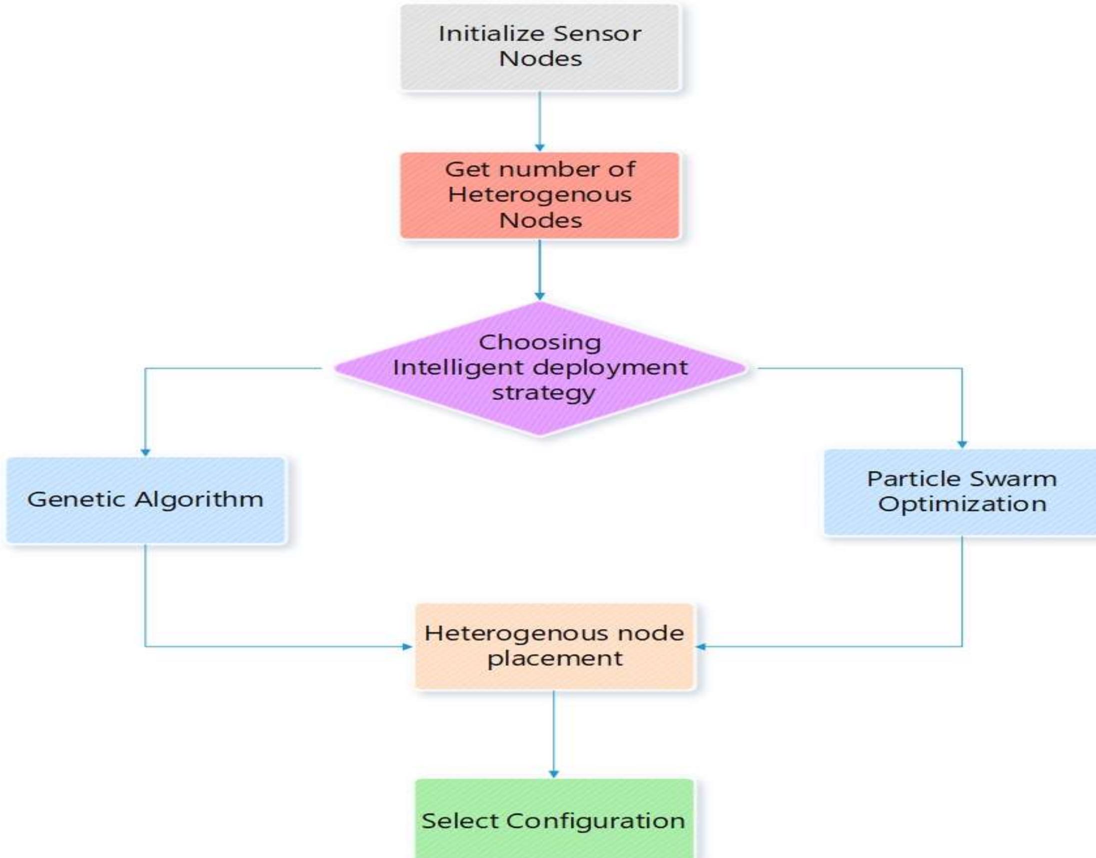

Fig 2: flow chart of the proposed algorithm.

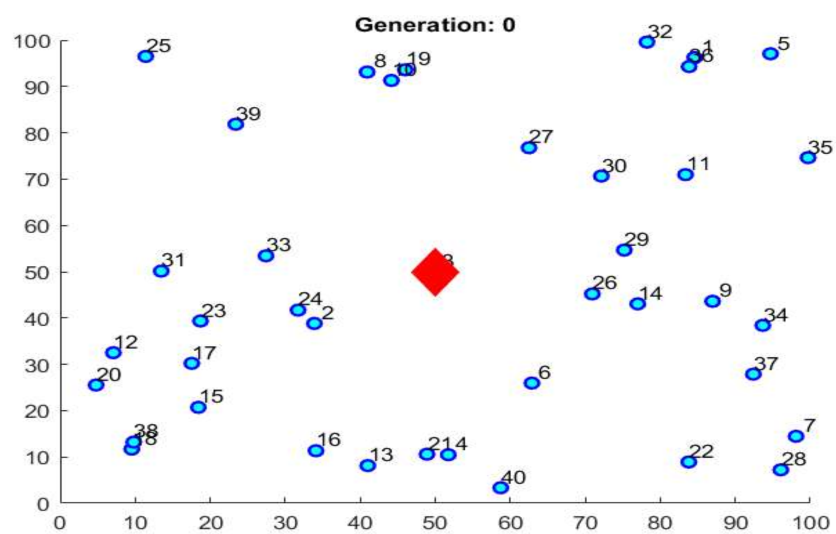

Fig 3: Random deployment of nodes in a dynamic environment

The above Figure 3 shows the deployment of nodes randomly in a dynamic environment using NS2 software for the simulation. Blue colour circles indicate the nodes and the red colour diamond shape indicates the master node. The master node sends the messages to all the nodes at generation 0. The numbers of sensor nodes placed in the network are in the range of 100 to 300. Each sensor node transmits data to the master node. The master node controls the routing of the packets from one node to another node. The master node also maintains the status of all the nodes, i.e., is the node is ready to receive the packets or is it in sleep mode, or traffic for a particular node is high or not. Based on the information sent by the nodes, the master node takes the corresponding action to manage the network. For example, if any node is in sleep mode, then the master node applies the dynamic routing algorithm and finds the alternate path to reach the destination. [12]

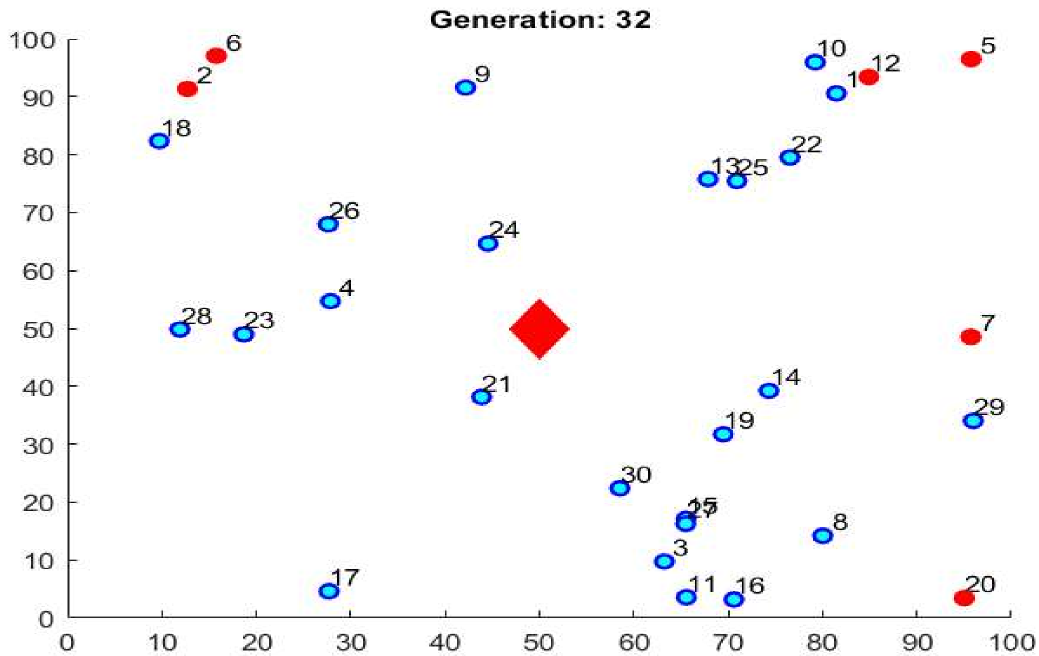

Fig 4: Results after simulation using intelligent algorithms for network coverage in NS2

In generation 32, some of the nodes will be in sleep mode and they are able transmit and receive the packets. Then the master node applies the proposed intelligent dynamic routing algorithm and finds the alternate or other different paths to transmit the packets to the destination node. The master node keeps the track of all the nodes that are present in the network, i.e., whether nodes are in active mode or sleep mode. When the nodes enter the active mode from the sleep mode and this information is sent to the master node as shown in fig 4. Then the master node immediately updates the routing table for the network. After the updating, the packets are transmitted from the source node to the destination node through the updated shortest path. [13]

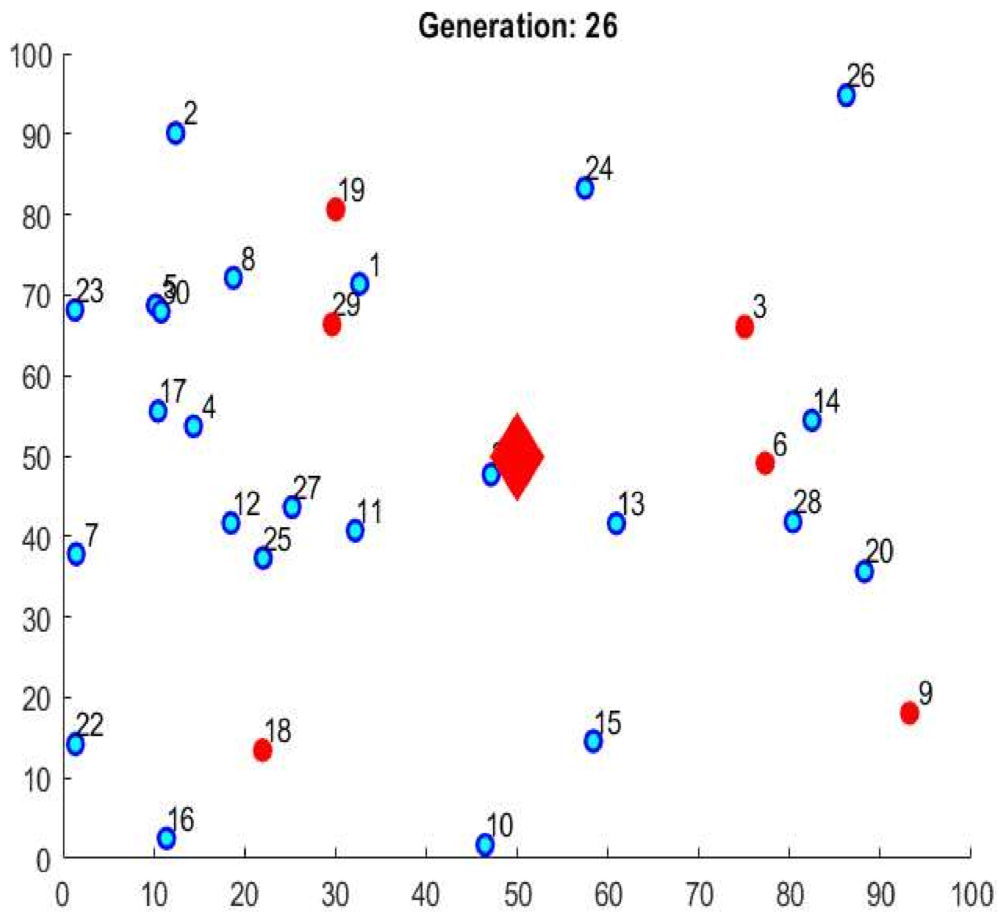

Fig 5: Data transmission through Multihop transmission for different sources and destination

The above Figure 5 shows the transmission of the data by the multihop transmission using the various nodes. The packets from the source to the destination are transmitted through the multi-hop between the nodes that are ready to receive and transmit the packets. It excludes the nodes which are in sleep mode or not ready to receive or transmit the packets. This routing from the source to the destination is done by the proposed dynamic routing method. This can also be implemented for multiple sources and multiple destinations, by routing the packets in a multi-hop manner. [14]

4. Results and discussion

Varying Sensor Nodes for Multihop transmission

In multihop transmission, variation in the number of sensor nodes can happen with homogenous nodes and also with heterogeneous nodes. In this paper, we have considered the variation of the heterogeneous nodes for data transmission using multi-hops. [15]
For the first case, we have conducted a series of simulations in the NS2 platform for variations in the sensor nodes by considering the two terrain sizes, one is 500x500 and another is 1000x1000. We have given the energy of the initial node as 0.5 with the initial heterogeneous energy of the nodes as 1.5. For each configuration, we have made five trails. The number of sensor nodes considered for the simulation is from 100 to 300, and the number of heterogeneous nodes in the network is 30. [16]

Terrain Size : 500x500, 1000x1000
Initial Sensor node energy : 0.5
Initial Heterogeneous node energy: 1.5
Trials per configuration : 5
Sensor Nodes : 100-300
Heterogeneous Nodes : 30

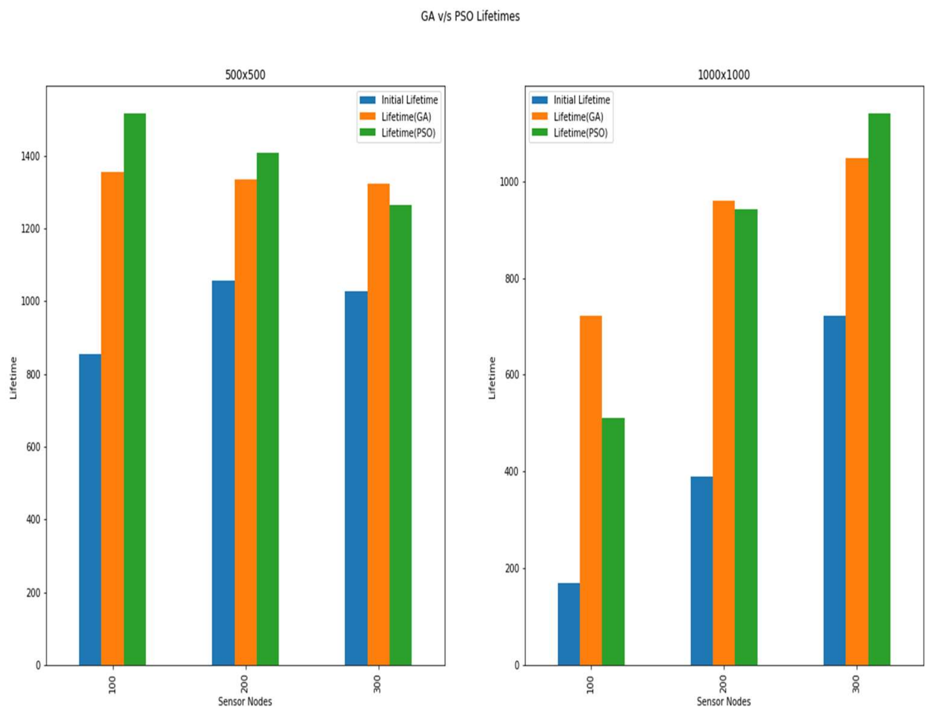

Fig 6 : comparative analysis of life time for 500 X 500 and 1000 X 1000 nodes

Lifetime Comparison:-The graph of the number of sensor nodes versus lifetime is plotted by considering initial lifetime, lifetime (GA), and lifetime (PSO). The graph gives a comparison between the lifetimes of GA and PSO. From the above graph, it is observed that the lifetime of the PSO is longer when compared to the lifetime of GA when the number of nodes is less, i.e., for 100 to 200 nodes. But when the number of nodes is increased say 300, the lifetime of GA is longer than the lifetime of the PSO [17]. This is shown in the above Figure-6 for the terrain size of 500x500. Next, we increased the terrain size to 1000x1000 and repeated the simulation. The graph of the lifetime of GA versus PSO is plotted and is shown in Figure-(B). In this scenario, the lifetime of GA is longer than the lifetime of the PSO for less number of nodes say 100 to 200. But for more number of nodes say 300 nodes, the lifetime of PSO is longer than the lifetime of the GA. Thus, for large terrain and more number of nodes, PSO gives a longer lifetime when compared to the GA. [18]

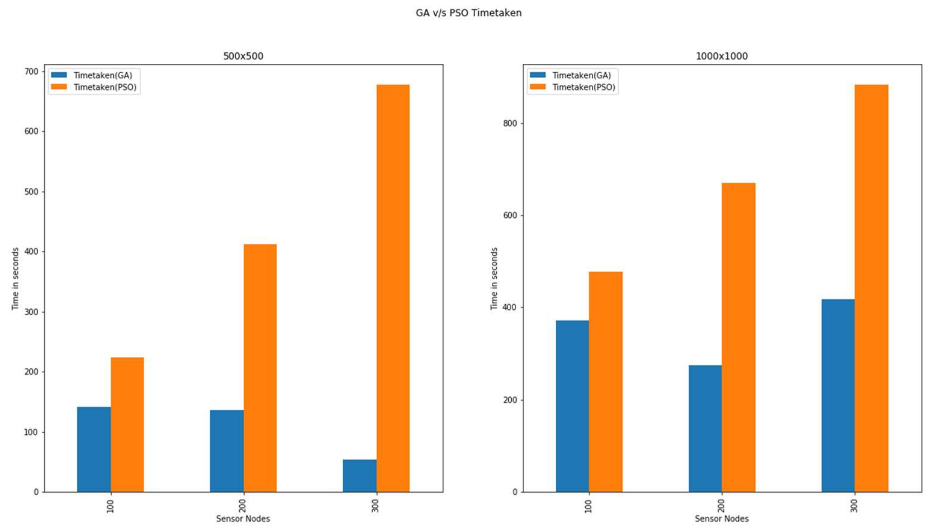

Fig 7 Time to solution Comparison of nodes present in the network within coverage

The above Figure 7 shows the graph of number of sensor nodes versus the time taken by the sensor nodes to respond in seconds. From the graph shown in Figure-(A), it is observed that the time taken by the PSO is more when compared to the time taken by the GA for variations in sensor nodes from 100 to 300. This is a scenario when the terrain size is 500x500. Next, we increased the terrain size to 1000x1000 and again conducted the simulations [19]. The graph of the number of sensor nodes versus the time taken is plotted and is shown in Figure-(B). From this graph, it is observed that the time taken by the GA is less when compared to the time taken by the PSO. Thus, the time taken by the GA is less for the variations in the sensor nodes and also variations in the size of the terrain.

Varying Heterogeneous Nodes for Multihop transmission

Next, to know the performance of the system in terms of the lifetime of both GA and PSO, the variation in the number of heterogeneous nodes is done by conducting a series of simulations in the NS2 platform [20]]. The number of sensor nodes considered for the simulation is 150, and the number of heterogeneous nodes in the network is varied from 10 to 30 and is given below.

Terrain Size : 500x500, 1000x1000
Initial Sensor node energy : 0.5
Initial Heterogeneous node energy: 1.5
Trials per configuration : 5
Sensor Nodes : 150
Heterogeneous Nodes : 10-30

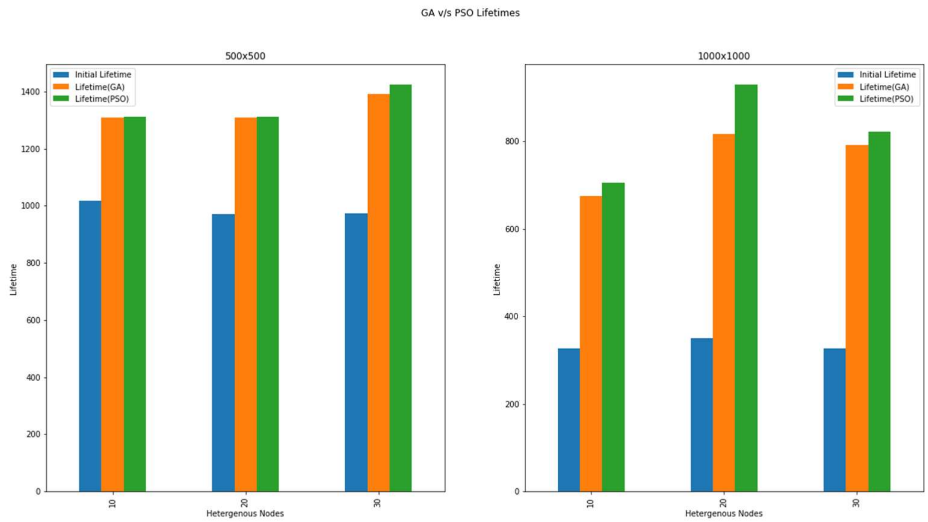

Fig 8 compartive life time analysis of heterogenous nodes for 500 X 500 and 1000 X 1000

Lifetime Comparison:-The graph of the number of heterogeneous nodes versus lifetime is plotted by considering initial lifetime, lifetime (GA), and lifetime (PSO)and is shown in the above Figure 8 [20]. The graph gives a comparison between the lifetimes of GA and PSO. From the above graph shown in Figure 8, it is observed that the lifetime of the PSO is longer when compared to the lifetime of GA when the number of heterogeneous nodes varies from 10 to 30 in a terrain of size 500x500. Next, we increased the terrain size to 1000x1000 and repeated the simulation. The graph of the lifetime of GA versus PSO is plotted and is shown in Figure-(B). In this scenario also, the lifetime of the PSO is longer when compared to the lifetime of GA, when the number of heterogeneous nodes is varied from 10 to 30. Thus, the lifetime of PSO is larger when compared to the lifetime of GA, for the variation in the heterogeneous nodes irrespective of the terrain size. [21] [25]

Varying Sensor Nodes for Direct transmission

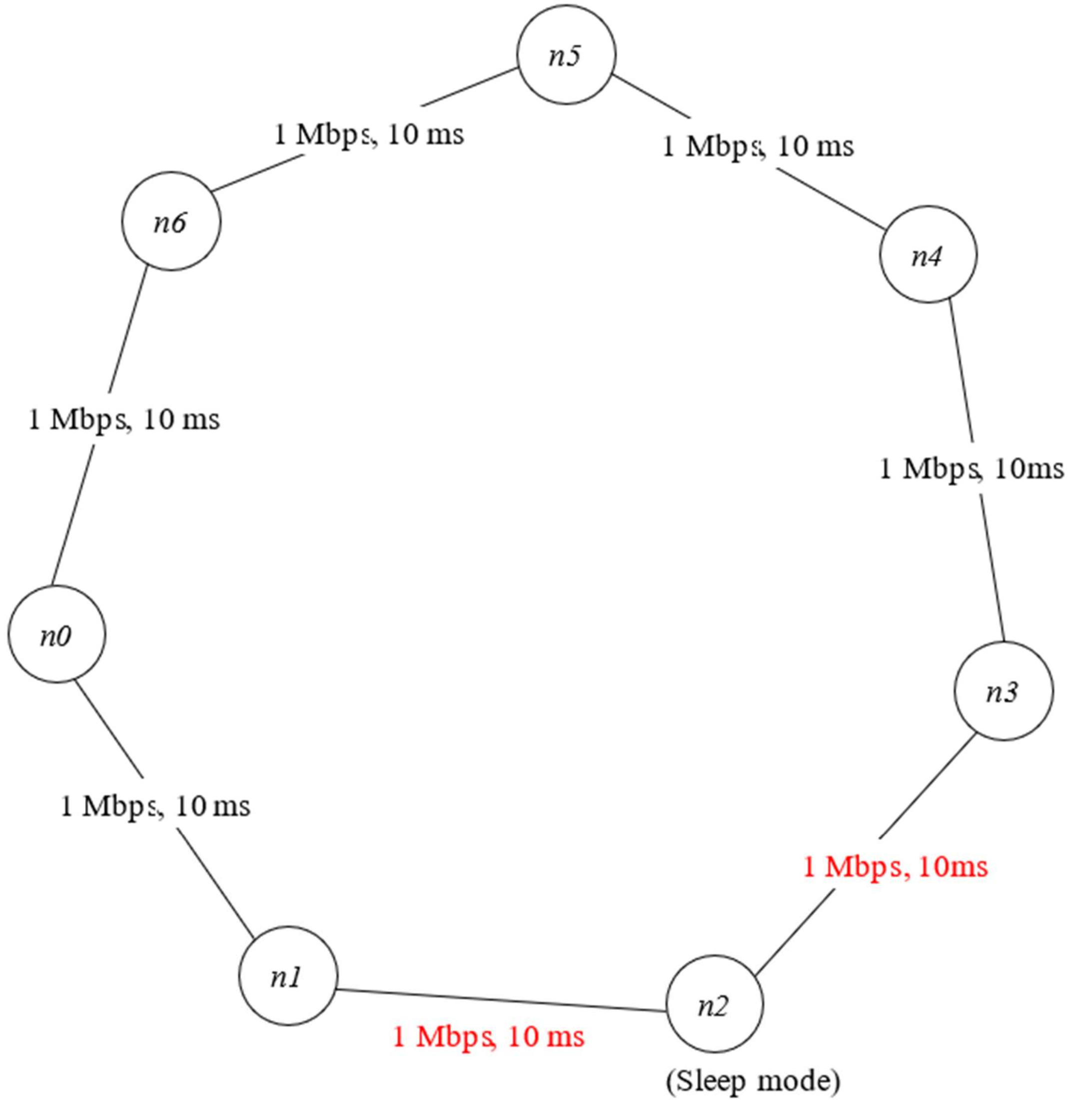

Figure 9: Arrangement of varying nodes in the network for direct data transmission

The above Figure 9 shows the arrangement of varying nodes for the direct transmission of data. Here, the data rate is of 10Mbps and the delay given is 10msec. Initially, all the nodes are in working condition, i.e., they are capable of transmitting and receiving the packets [22]. The data transmission for example, from node-0 to node-3 begins at 0.50 seconds as shown in Figure 10. The shortest path from node-0 to node-3 is: N0 → N1 → N2 → N3 and is shown in Figure 10..

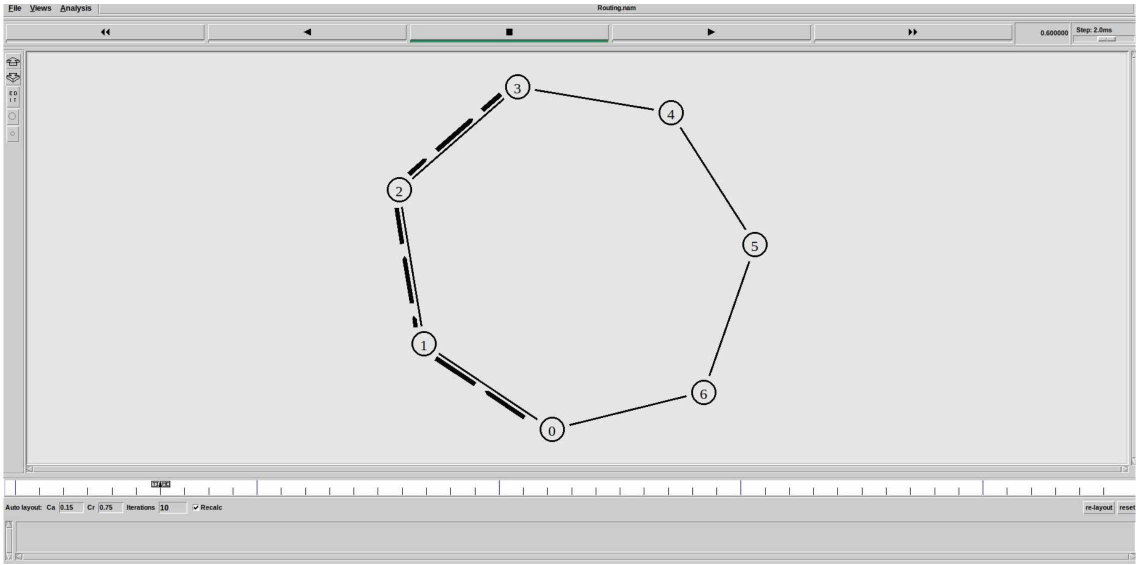

Fig 10: Starting from 0.5s node n0 sends data traffic to n3 taking the shortest path

Let node-2 go to sleep mode, i.e., it is not ready to take the incoming packets or to transmit the packets to any other nodes after some time, say at 1.0 seconds, as shown in Figure 3. Now, node-2 does not receive or transmit the packets. Thus the links N1→ N2 and N2 → N3 are not working. Therefore, the packets will drop at node-2 and as shown in Figure 11.

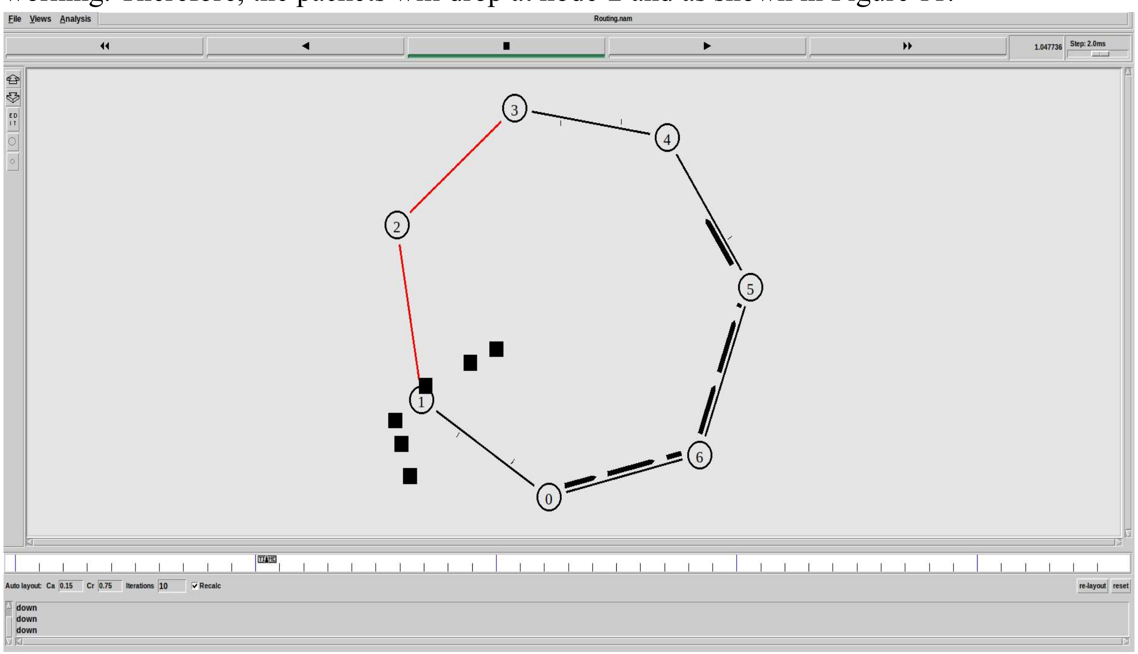

Fig 11: At 1.0 packets are dropped as node n2 goes into sleep mode resulting in link failure between n1-n2 and n2-n3

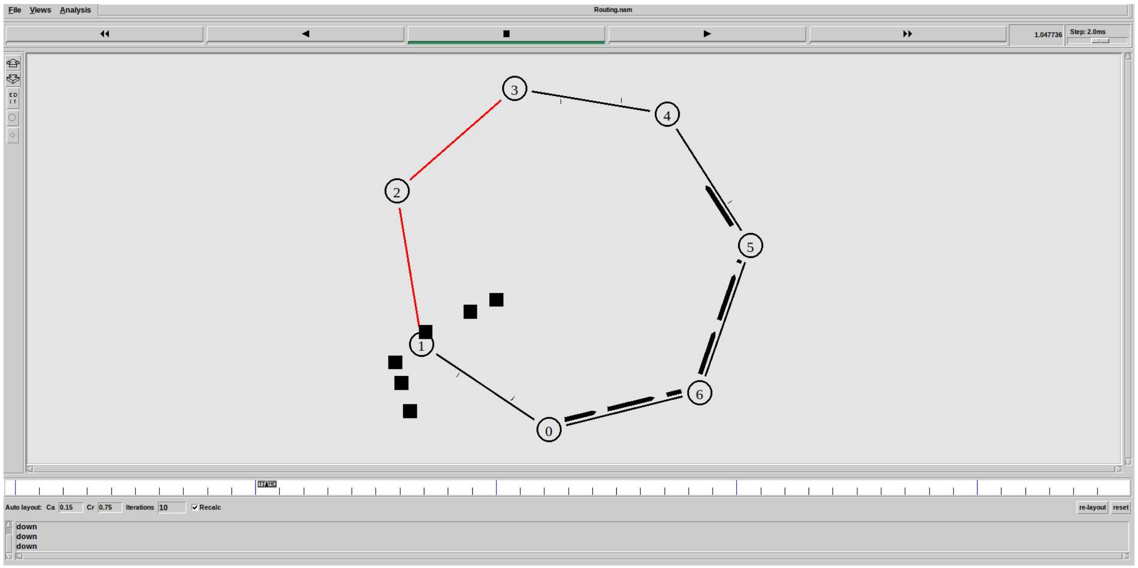

Fig 12: Dynamic routing ensures data traffic flows through a different route

Now by applying the dynamic routing algorithm, the network starts finding the alternate or different route from node-0 to node-3. The alternate route found was N0 → N6 →N5 → N4 → N3 and is shown in Figure-4. And the packets were transmitted from this path as indicated in Figure 4. Let node-2 wake up after 2.0 seconds, and this information is circulated to all the nodes in the network[23]. Then the shortest path is again computed and the path from node-0 to node-3 is now, N0 → N1 → N2 → N3, which is shown in Figure-12. Figure 13 also shows that packets are now transmitted from node-0 to node-3 through this new path as per the dynamic routing algorithm. [24]

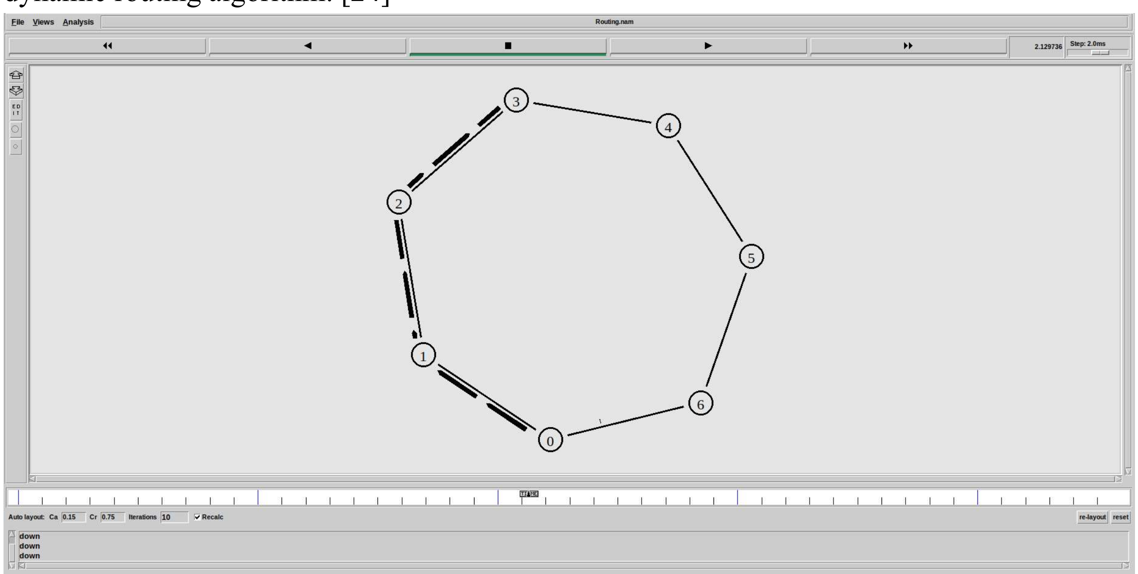

Fig 13: After 2.0s, node n2 is re-established and takes the shortest route

5. Conclusion and future scope :

The present reserarch presented here has been developed in the NS2 platform by considering the different nodes of evalaution and demonstrated for the increased capacity in terms of parameters subjected to the genetic algorithm and particle swarm algorithm. With the obtained resutls it can be concluded that the proposed system has done the operation of the network reconfiguration by finding the shortest path in the network to reach the destination . in the results it is tabulated to have the supportiv results for the genetic algorithm in the wireless sensor network under consideration, hence it can be noted that the genetic algorithm has achieved the better results in the network architecture in both heterogenous and homogeneous combinations.

As an part of future scope for the developed system it can be tested for the other protocols with the same platform of network simulator and developing of suitable networks as basic building blocks with network architecture.

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