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Path Generation Protocol to Improve Lifetime of WSN

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Abstract

In WSN sensor nodes are connected to their neighbor nodes by a wireless channel and these all nodes are operated on a battery to perform any operations. So improving the lifetime of WSN is a major research challenge by effective utilization of each and every node's energy. The lifetime of WSNs can be improved in three steps: path creation, path selection, and power saving. In existing works, path selection has the major role to utilize and enhance lifetime. In the proposed PStack algorithm, path generation is a major concern, and routing is applied. It takes advantage of and solves the limitations of existing algorithms using the stack concept in WSN. The proposed algorithm shows a better result than the improved LEACH protocol because it uses the data structure with graph theory.

Keywords: WSN, AODV, CDS, KMAT, DSR, stack.

1. Introduction

Basic foundation of any kind of network communication is path generation from source to destination. Especially in the WSN path generation has a major role. A better path generating between source and destination leads to optimized load balancing and achieves high lifetime. Most of the existing models have single backbone meaning that it creates a single path in network with single backbone, may not be ideal to prolong the lifetime[1]. A simple WSN model is considered with six sensor nodes and a sink as depicted in figure1. It is understood that all sensor nodes are kept active 24X7 irrespective of whether is it in use or not. This leads to unnecessary usage of battery power leading to drain down quickly. Therefore the node automatically disconnected itself from its neighbours[5].

In this work node's energy means all node's energy not only the selected nodes energy. Because improving the node's energy may not able to prolong the lifetime, it can be happen only when all nodes energy will be utilize effectively without wasting any nodes energy. According to the review of literature, there are various techniques introduced and

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implemented to improve the lifetime of WSN. All these techniques were applied either in routing algorithms or region (area) of WSN as cluster. These techniques may be categories as: 1. WSN with single sink and 2.WSN with more than one sink.

WSN with single sink is capable of using multipath with all redundant nodes. But select a single path for communication, keeping all other paths inactive inorder to save energy of rest of the nodes. WSN with more than one sink is implemented to have successful communication with the sink even in the situation where sink's neighbour nodes battery drains. This technique replaces the sink's neighbour nodes with multiple sink.

In both the cases, there were no suitable solutions found to achieve high lifetime because of activating all path communications by neighbouring nodes to sink. Hence the possibility of drain down of battery of sinks neighbouring nodes is high. As the communications are concerned, it can be single path(TCP) and multiple path(UDP). The single path communication may not be suitable approach for WSN. As the nodes are in regular or continuously use and the possibilities of battery of nodes getting drained is very high. This leads to communication failure once the battery drains in any of the nodes involved.

So the multipath communication is considered to be the best solution as all the paths are utilized for the communication. Hence, there is an optimal load distribution in terms of battery usage of all nodes thus leading to optimum power saving. It has been identified that an effective algorithm is essential to work with multipath and multisink making effective communication between source and sink by choosing the nodes of a single path making all other nodes inactive. This helps to save the battery of neighbouring nodes.

This paper is organized into 8 sections as mentioned below like literature survey, proposed methodology, problem statements, proposed system architecture, PSTACK algorithm, implementation and conclusion with references.

2. LITERATURE SURVEY

In this work [1], the energy efficiency of routing candidate nodes is placed irregularly in a linear network, using the Dynamic Programming method, the energy efficiency of routing candidate nodes is distributed irregularly in a linear network. Within the candidate nodes, this algorithm is used to find the best route node and change the transmission range. The dynamic programming algorithm is split into two sections: obtaining the minimal energy and information, and constructing the route node. The results have been obtained by implementing various formulas to only certain domains such as the transmission of energy consumed per second, identifying the shortest hops with the least amount of energy consumed, energy consumption by sensors near active nodes, and so on.

In this work[2], authors are presenting a scheme of reprogramming which is used to reduce the energy consumption and also collisions when there is transmission of messages from sender to the receiver. Since it is a wireless transmission there will be loss of data and also redundancy. To overcome all these problems the protocol designed is DTPC (dynamic transmission power control), this protocol enhances in the fields of energy consumption, transmission power, frame with inference, packet losses and retransmission times better than MNP protocol. The protocol has been proven using the simulator OMNeT++ results, which is an analysis of the energy consumption of a sensor network environment.

S. K. A. Imon [3], proposed Randomized Switching to Maximize Lifetime (RaSMaLai) technique to improve the lifetime of WSN by load balancing with low temporal complexity. This work is extended for the distributed WSN and it's called as D-RaSMaLai. Simulation result of this work is found better performance than existing system. Limitation: This work does not have the consideration of the characteristics of the switching probability function at different network parameters to reduce the convergence time.

In this work [4], Author's specify the power management of sensor nodes (SNs) by minimizing the active nodes for better performance. These sensor nodes are divided into subsystems and these subsystems have 4 domains such as: communication subsystem (radio), computing subsystem (memory), sensing subsystem (analog to digital) and power supply subsystem (power source). The main purpose of the authors is to extend the power system of the battery since it is WSN environment. The approach used here is MIPQ problem solving with Dynamic Power Management methodology, which consumes less energy of the battery by turning on the active nodes and turning off the sleeping nodes. The platform used is MATLAB.

[5- 10] In these works authors are implemented AODV, DSDV and DSR to create the virtual backbone network using Connected Dominating Set (CDS). It is used to form the backbone network. CDS having the several drawbacks while creating the path from source to sink. It considers only neighbours' nodes. In these works authors used the sleeping algorithm to TURN ON the nodes which is participating in the communication through path.
[11] This work is divided into two parts: new disjoint set Division (SEDO) algorithm and routing algorithm in WSN to improve the network connectivity and lifetime. SEDO is dividing the network in set of sub networks which is similar to construction of backbone network from source to sink. Routing algorithm is to select anyone sub network during the packet transmission. It's difficult to achieve both low energy consumption and high connectivity in WSN at the same time.
[12] In this work author designed Full Area Coverage Optimization technique to improve the lifetime of WSN. It uses probability sensing model and select only a set of nodes for communication from source to sink. It's very difficult task to verify the coverage of a full continuous area in WSN.
[13- 14] In this work authors proposed RPA algorithm and PSO (Particle Swarm Optimization). This algorithm first finds out the maximum independent sets of sensor nodes, then dividing that set into clusters and assign cluster head to each cluster, for the communication applying CDS on cluster heads, scheduling algorithm will select any one path from source to sink then sleeping algorithm will TURN ON that selected cluster's head nodes (all other nodes will be OFF). Limitation: this work achieves the lifetime in case properly arranged and less nodes in cluster. But it won't achieve lifetime if number of nodes will be more in cluster. CDS also having their own drawbacks in path creation.
[15] This work is the modification in Dijkstra's algorithm and implemented on the JAVA island to save the energy and distance from one place to another place. It achieves 92.88 % accuracy with respect to the Google Map. Limitation: Algorithm takes more memory and use of this in WSN is more complicated.
[16] This work is related to the reduction of energy usage in transmission of nodes without substituting the quality of a link. The energy consumption is reduced only because the battery of sensor nodes is smaller in size and cannot extend for a long time, hence the energy has to be consumed by not letting uncontrolled power transmission happen. The methodology used is PID (Proportional Integral Derivative) and RSSI (Received Signal Strength) for the transmission power control and the system DTPC is evaluated by using the closed loop feedback technique.
[17] In this work, the authors compare with other paper analysis to improve the lifetime of the Dynamic Power Management. The proposed Dynamic Power management model is been executed using MATLAB following with the queue (FIFO) theoretical approach. Here the performance is evaluated using mathematical formulas and try estimating with the optimal values.
[18] In this work, the sensor nodes are organized into clusters and this cluster has an important node called as Cluster Head. This cluster head (CH) gathers sensed data from the SNs and transfers to the Base station. The performance of transmitting nodes and consumption of energy has been compared to LEACH protocol from proposed system. Because there are three drawbacks of LEACH protocol and the proposed system enhances all these problems with efficient solutions. The system is performed on MATLAB 2015a with Elliptical Gaussian distribution implemented resulting in 60% extending network life cycle that of LEACH protocol.
[19] In this work, Author's share a deep look about WSN applications which can be done with or without infrastructure. In this, dynamic programming of deterministic approach is used in the sensor network to solve the routing algorithm issues and makes it more efficient. The result of this work shows the enhancement in energy compared to the existing routing algorithm in WSN.
[20-21] In these work, authors mentioned the involvement of the WSN (Wireless Sensor Network) in the present generation with respect to the data transmission, protocol used in communication and limited power supply using battery. In this researcher is concentrating more on the Enhanced Energy-Efficiency and proposed a better LEACH Routing Protocol which helps to reduce the energy consumption, when node sends the information at a low distance to the sink. Nowadays in this environment things are monitored using Sensors and these sensors are energy-limited therefore the sensors cannot be either recharged or replaced. Hence the motive of this protocol is to extend the lifespan of the sensor networks. This vital challenge made an energy efficient design, which solved the problem of working the Sensor Node for a long period with less usage of energy. The simulation was performed in MATLAB2016b platform with parameters: like number of nodes, number of sinks, sink location and so on. This got a better result than the LEACH protocol.
[22] In this work, other than reducing the energy of transmission the identification of error bits is done. This is done to avoid transmission of error bits which unnecessarily consume energy. The bit error rate (BER) done are by encoding

-> (Group definition, Alignment, Concatenation) decoding and enhancement. The platform used to perform BER is MATLAB using AWGN channel.
[23-24] In this work, ERRS (Energy efficient and reliable routing scheme) is implemented to enhance the energy efficiency of routing protocol with stable resource in the WBAN (wireless body area network). It works node selection using the forwarder node rotation technique. It results up with 26% using MATLAB platform which contributes a graphical and interactive environment.
[25-27] In this work, Authors compare the massive number of sensor nodes which is used for the data collection, process and transmit to the neighbor node to Base station. It establishes a fresh Grid Based Energy-Efficiency Cross Layer Optimization Model in wireless sensor networks using DUAL MOBILE SINK that is GEECLO. This mainly does grid partition, clustering and routing. Here to select the best or optimal path of communication is done by Dolphin Swarm Optimization Algorithm (DOSA) which is a routing process. In this entire sensor network is divided into zones and sub zones. GEECLO routing technique is used to enhance the energy efficiency and lifetime of the WSN. Experimental Result of this work shows high energy efficient because of appropriate cluster head selection and optimal route selection for communication using GEECLO.

3. PROPOSED METHODOLOGY

3.1. Protocol Design:

1. Deploying the sensor nodes to form the WSN.
2. Track the major parameter of each and every nodes such as location and range.
3. Apply the path generation technique on the step2 information to construct the all possible paths from source to sink(multipath).
4. Send and store all paths information to sink.
5. Apply the path selection technique to select any single path for the communication from multipath on the basis of number of nodes involved and node's energy.
6. Switch the path for communication.
7. Apply the power saving technique to TURN ON only the selected path nodes for communication.
8. Start the communication.
9. If communication completed (only once), terminate the path. Goto step 5.
10. If step 5 doesn't able to select any path, then it clearly indicates that each and every nodes energy level is not capable for communication.

3.2. Introduction to the new protocol

To increase lifetime of Wireless Sensor Network the communication protocol has to consider the following major research techniques which can solve the energy consumption challenge. These are:

1. Path generation technique/algorithm.
2. Path selection technique/algorithm.
3. Power saving technique.

Path generation technique: this technique deals with all possible path generation from source to destination (sink).

Path selection technique: This technique deals with selection of path for transmission the information from source to sink. It can also called as the routing algorithm. This algorithm can not select the path randomly, there should be some protocol for path selection that protocol may be based on the two things: energy level of nodes as well as less number of nodes in the path. Path should first check the energy level of node, if the node having high energy level then that node's path will be selected then it will check the number of nodes present in the path to break the tie, and select the less number of nodes path.
Power saving technique: this technique has to specify the nodes which has to be TURN ON or TURN OFF. WSN supports redundant nodes that means there will be n number of nodes with same coverage area. Therefore this technique has to select any one node from that area and TURN ON that node, rest all nodes will be TURN OFF.

Selection of node should be TURN ON information will come from the path selection technique, whatever path will be selected that path nodes only has to TURN ON.

4. PROBLEM STATEMENT

A. Existing System: There are n number of works done on the WSN to achieve the high lifetime such as clustering technique, AODV deployed in WSN, Virtual Backbone Scheduling and so on. All the above work which is mentioned in the literature survey or in general path generation and path selection is having the important roles in networking as well as in WSN. Because of path only throughput, performance and any other parameters can improve.

B. Proposed System: The proposed system will consider path as major challenges in improvement of lifetime of the WSN. So proposing new protocol for path generation in WSN named as PStack Algorithm. In this protocol all nodes will equally and effectively participate in the communication, which will enhance the lifetime of WSN.

5. PROPOSED SYSTEM ARCHITECTURE

Major role to maximize the lifetime of WSN is considered as path generation techniques. Because once all path is properly generated with all nodes then only scheduling and power saving techniques can apply in WSN.

Functionalities of Sink: 1. Sensors register with the sink with its IP address. 2. It receives the data from the sensors. and 3. It stores the received data.

Functionalities of Sensor Nodes: 1. Sensors keep sensing. 2. Corresponding sensors sense the corresponding data. 3. Sensors keep checking the battery level. According to that data selected path Sensor is decided. and 4. Each path's nodes update the data (battery level and sensed data) to the sink.

A. *PStack Algorithm (Path Generation):*

There are two major considerations in this work:

1. Reduce the power consumption of WSN.
2. Effective utilization of energy of each and every nodes present in WSN that means all nodes of WSN should participate in the communication.

With respect to the above consideration to design PStack Algorithm for the path generation. There are several worst case scenarios such as: isolated nodes, pendent nodes and self-path nodes, which has to be considered while designing.

List of assumptions and consideration while constructing the PStack Algorithm, which can eliminates the drawbacks and use the advantages of all existing system. These are listed below:

1. Initial assumption is that each nodes will have their unique node number, least number will represent the source and highest number will represent the destination (sink).
2. Isolated nodes: Nodes which doesn't come in the range of any nodes in the WSN.
3. Pendent nodes: Nodes which having the range but cant reach to the destination or don't have outgoing path towards the destination node.
4. All nodes should participate in the communication except isolated and pendent nodes.
5. Protocol should select the neighbour nodes from source towards the destination not to backward. So this protocol has to create matrix and select the upper path of the diagonal of the matrix.
6. If WSN having large number of nodes or one WSN wants to communicate with another WSN, then sink to sink communication can be made.

6. PSTACK ALGORITHUM:

Assumptions: source is always given minimum number and destination is given the maximum number.
Input: n- number of nodes, a[n][n]- adjacency matrix.
Output: stack of different sizes.

1. k=0;
2. for loop1 i=1 to n
3. for loop2 j=i to n //j starts from i to avoid repletion of paths
4. if a[i][j]= = 1
5. call the method stack(i , j);
6. end if
7. increment k, k++
8. end for loop1 and loop.
9. for loop1 i =1 to m //to print all possible paths between source and destination
10. if ((stack i [top]==destination)&& (stack i[bottom]==source))
11. print stack i.
12. end if
13. end for loop.

Stack method:

1. stack(int i, int j) //stacks of size 2 is created for every edge between nodes
2. start stack method
3. stack[0] = i;
4. Stack[1] = j;
5. Initialize m=0;
6. for loop1 i=1 to k
7. for loop2 j = i + 1 to k
8. if stack i [1] = = stack j [0] // top of each stack is compared with bottom of every other stack to get further connectivity
9. increment m+ +
10. call the method of create_stack(stack i, stack j [0]);
11. end if
12. end for loop1 and loop2
13. end stack method.

Create stack method:

1. create_stack(stack i, int k)
2. for loop i =0 to 1
3. stack m [i] = stack i [i];
4. close for loop
5. stack m [i+1] = stack j [0]; //combines values of both stacks i and j and creates a new stack m
6. end create_stack method.

This algorithm having two methods stack and create_stack. Stack method is responsible to create the stack of size two means it will create stack of node with its all neighbour's node. Create_stack method will update the stack if created stack by stack method with the comparison of bottom of stack to the top of another stack. If its matching then it will be update. Create_stack method will update the stack till it reach to the destination. So finally algorithm produces as a set of stack, which will represent set of paths from source to sink. Major advantage of this algorithm is that stack length will give the number of nodes of each path, which can be used for the path scheduler algorithm to select the best path which can improve the lifetime.

7. IMPLEMNATATION OF PSTACK ALGORITHM

PStack Algorithm can be used in any number of nodes for the simulation of the work. WSN shown in figure1 having the 11 sensor nodes and one sink node, adjacency matrix of this WSN is shown in below figure2.To evaluate the performance of PStack Algorithm, two more algorithms are implemented on the same WSN such as AODV with Dijkstra's, and CDS(used in VBS, NBS and all backbone networks). These algorithms will be implemented to measure the performance of PStack Algorithm.

Implementation of AODV with Dijkstra's Algorithm: Figure3 shows the path generated by AODV, this algorithm will generate path on demand means when path will be requested for communication with the help of flooding

technique. Therefore in each communication all nodes will be active for constructing the new shortest path. And this algorithm wont achieve the high lifetime.

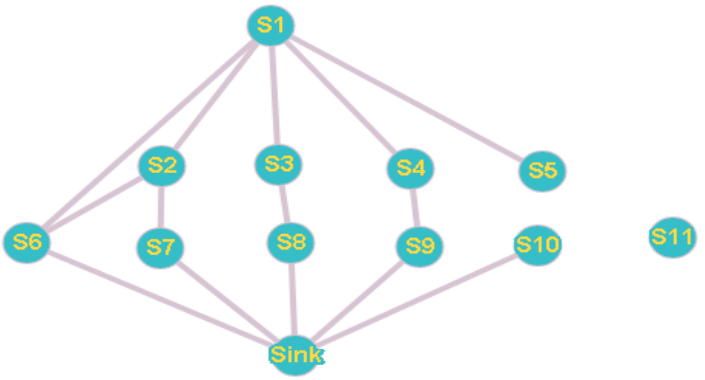

Figure1: WSN with 11 sensor nodes and one sink

S1-> 0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0,
S2-> 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0,
S3-> 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
S4-> 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
S5-> 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
S6-> 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
S7-> 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
S8-> 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1,
S9-> 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1,
S10-> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
S11-> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
Sink-> 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0,

Figure 2: Adjacency Matrix of WSN

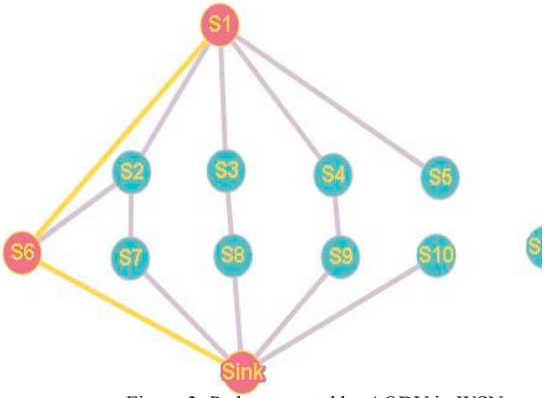

Figure 3: Path generated by AODV in WSN

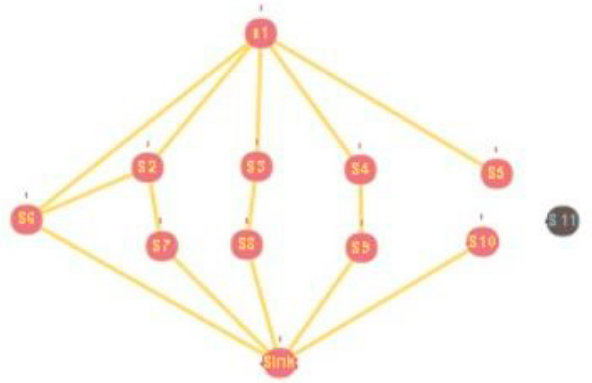

Figure 4: Path generated by CDS in WSN

7.1 CDS: This algorithm is frequently used in WSN to generates the VBS(Virtual Backbone Scheduling), It will generate all the possible paths from each sensor nodes to its neighbor nodes. The sink will have the set of paths which will be considered as backbone network, then scheduling algorithm will select any backbone network for the communication and all other nodes which is not participating in the communication will be TURN OFF to achieve the high lifetime. Which is shown in above figure 4.

7.2 PStack Algorithm: In this algorithm all possible paths will be generated from the source to sink according to the range of each sensor nodes while keeping the consideration of redundant nodes. This algorithm will be have several assumptions and considerations such as pendent nodes, isolated nodes, unreachable nodes and so on, as shown in the above figure5.

Generated paths are:

S1->S6, S1-> S2, S1-> S3, S1->S4, S1-> S5
S2 -> S1, S2 -> S6, S2-> S7
S3 -> S1, S3 ->S8
S4 -> S1, S4-> S9
S6 -> S1, S6 -> S2, S6-> SINK
S7 -> S2, S7-> SINK
S8 -> S3, S8-> SINK
S9 -> S4, S9-> SINK
S10-> SINK

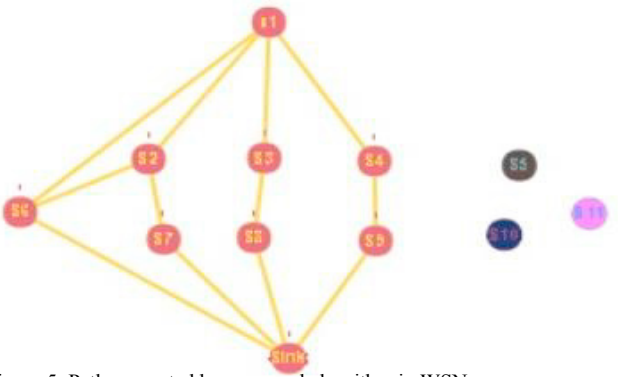

Figure 5: Path generated by proposed algorithm in WSN.

7.3 Steps for working of Pstack Algorithm:

Step 1: create stack of size two which have paths between and only one direction is possible. That means stack will be generated for all neighbor nodes. List of the created stacks are shown in below figure6.

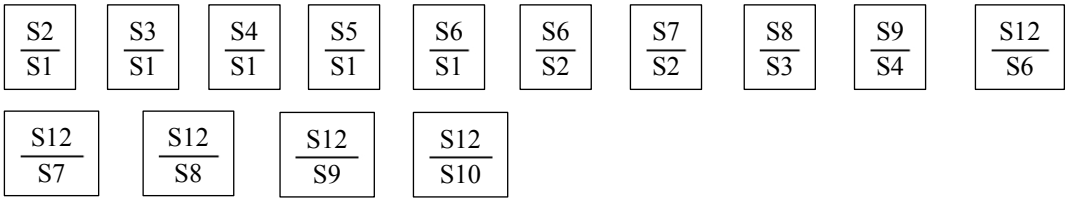

Figure 6: Outputs of step1

Step 2 : Each stack top is compared with every other stacks bottom, if its same(matches) then create new stack by merging both of the stacks.
Step 3: Repeat the step2 till top of the stck becomes destination or all stacks are compared.
Step 4 : print the paths from source to destination.

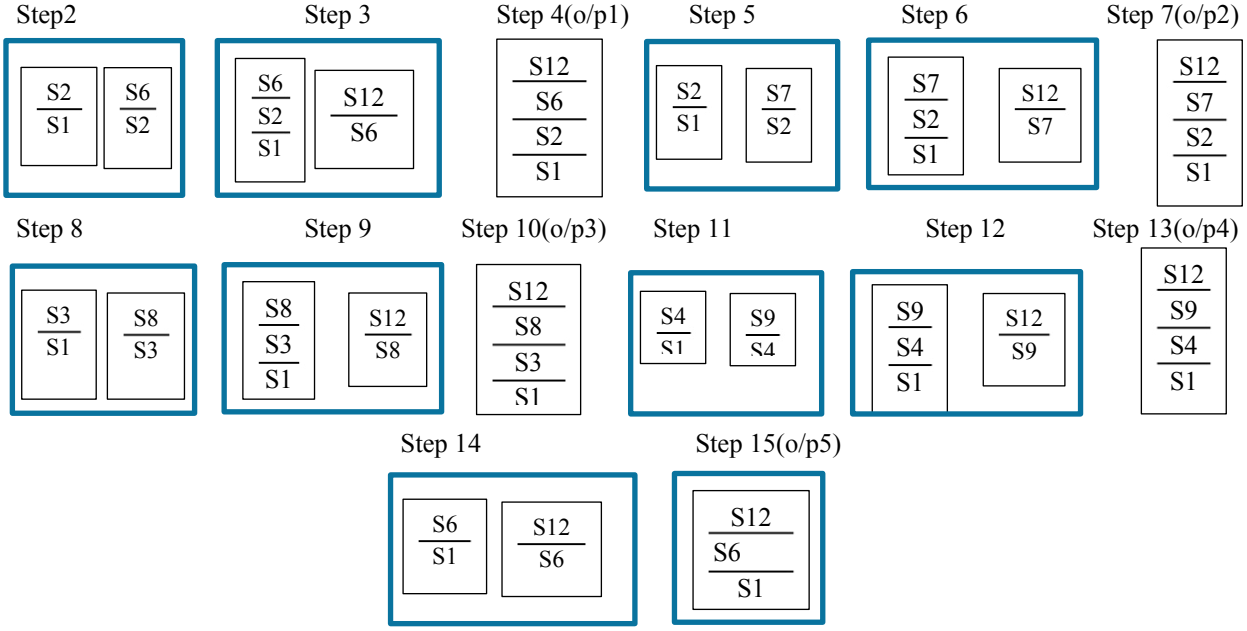

Figure 7: Outputs of step 2 to 15

After finishing the step15, which is shown in the above figure7, PStack algorithm will generated five stacks as the output which is the possible paths from source to sink. Length of each stack represents the number of nodes of each path (stack). So finally sink will have a set of all possible paths from source to sink as shown in figure above, now sink will apply path selection techniques as mention above to select the path for communication. Each and every time whenever communication occurs sink will update nodes information with energy level, sink will also have probability model for the energy calculation according to the provided battery energy and utilized energy during transmission.

WSN is deployed with one sink and 50 sensor nodes, each and every sensor nodes having the range of 40 meters. PStack algorithm energy consumption is shown in the figure 8 of the each node for transmission, Receiving and average energy level. This algorithm works more efficient when the number of nodes are getting increase with the help of the redundancy nodes in the network. When number of nodes increases, its decrease the overall average energy consumption of the network.

PStack algorithm implementation is compared with the MultiHop LEACH algorithm with the parameters such as: Number of nodes 100, Initial energy of each node= 1 Joule, probability of transmitting the packets of each node according to the energy threshold value=0.1, transmission energy of the node=0.1*10-7 Joule. In this PStack algorithm shows that more percentage of nodes are alive compared than LEACH with respect to the number of rounds which is

shown in the figure9.

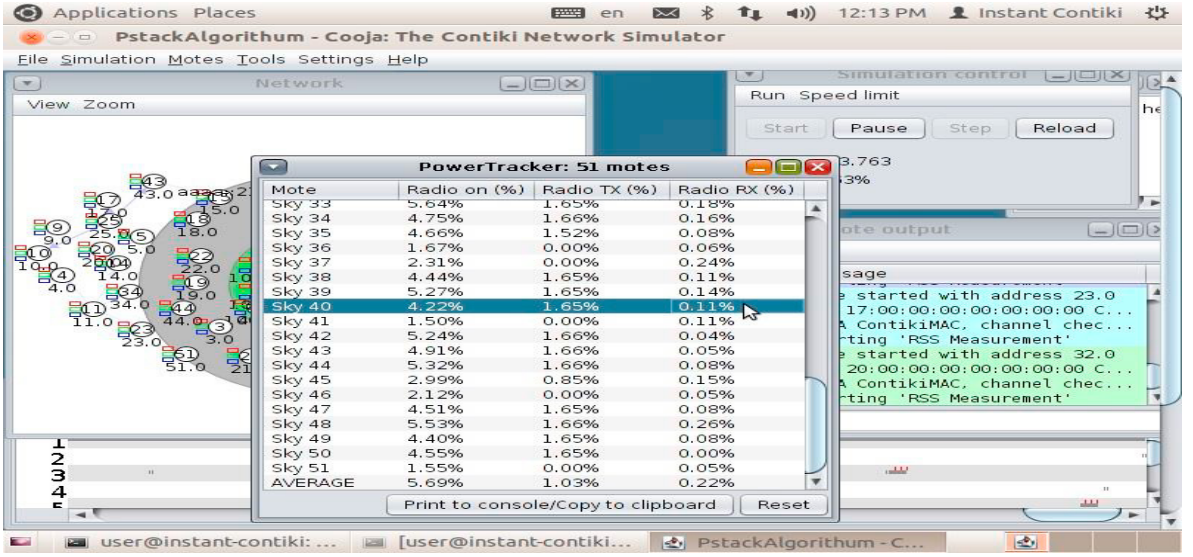

Figure 8: Energy consumption of each node for transmission, Receiving and average of the NW with 51 nodes

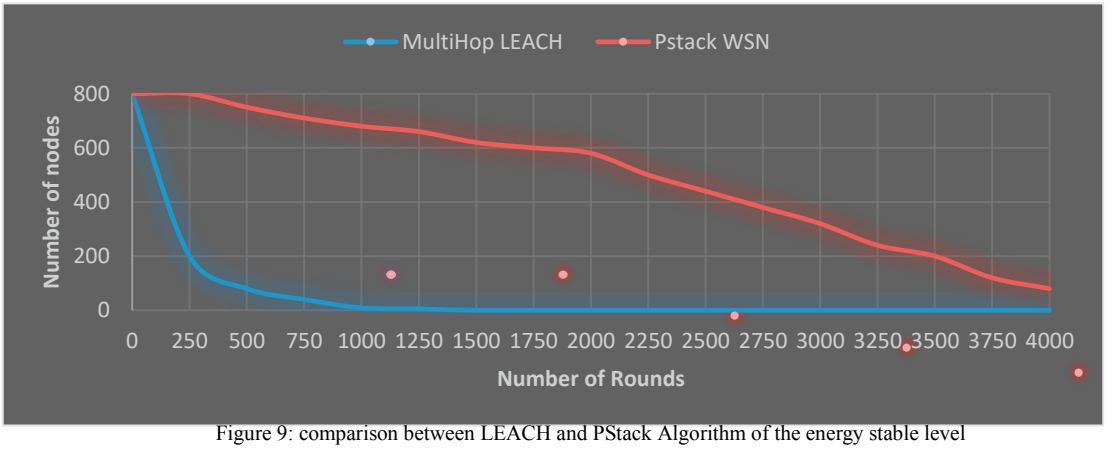

Figure 9: comparison between LEACH and PStack Algorithm of the energy stable level

Below figure 10 shows that when number of rounds increases same time number of alive nodes are decreases. But PStack algorithm having better alive nodes compare than LEACH.

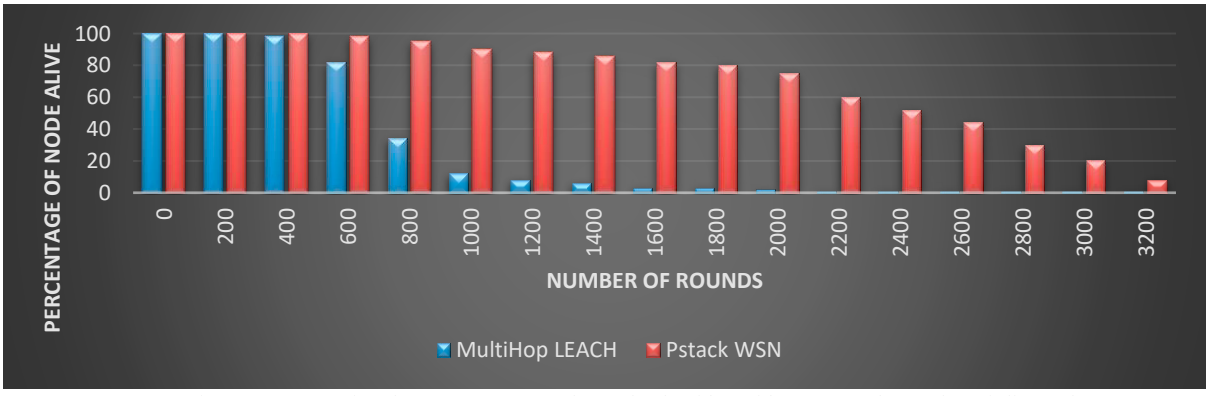

Figure 10`: comparison between LEACH and PStack Algorithm with respect to the number of alive nodes

8. CONCLUSION

PStack algorithm in WSN eliminate the drawbacks of all existing protocol, which is used for the improvement of lifetime of WSN such as AODV, CDS, KMAT, DSR, NBS, VBS and cluster. PStack algorithm results will be in form of the number of stacks with different sizes. Number of stacks represents the number of paths from source to sink and size of stack represents the number of sensor nodes in particular path which having the significant roles for path selection technique. This is the great way to improve the lifetime of any kinds of WSN. This algorithm works more effectively when density of nodes are high. It also supports for static as well as dynamic nodes in WSN.

Limitation of this work is that this assumption may have chances to become wrong if sensor nodes participated in any communication without knowledge of sink, or sink didn't able to update the energy level of nodes properly

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