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Novel Routing to Maximize Network life Time Using SWASTIKA Model

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ABSTRACT

The focus of this paper is to Maximize Network Life Time (MNLT) by minimizing node's load in context to wireless network. The nodes of Wireless Sensor Networks (WSNs) are called as a system on a board device, embodies of the board are a sensor, memory, processing devices, transceiver, GPS system and battery. WSNs are energy constraint networks, the battery associated to WSNs have fixed EMF and are installed and packaged before deployment of the node. By load balancing, the life of network can be significantly increased. The battery power dissipation of node is proportional to the outgoing traffic. Many algorithms have been proposed to handle the optimal use of battery power problems. In this paper the basic purpose of our network design model is to minimize the Total Power Consumption (TPC) and to lower the Average Power Consumption (APC) per node. We have done a fair coalition routing to send traffic from different nodes to sink following a pattern resembling SWASTIKA (卍), which is an ancient religious symbol, seems like an equilateral cross, with its four limbs bent at 90^0. Where we have done a fair adaptive coalition routing by routed the diagonal high power consuming traffic path to the orthogonal low power consuming traffic path following Dijkstra. We have simulated our model in Matlab and found that the total power consumed in our model is much less than the traditional way of sending traffic. The average load to a node in a network at all scale following SWASTIKA model found to be consumed less power compared to other standard routing models. Hence, the lifetime of our proposed network model can be extended up to double of its conventional lifetime.

Keywords: SWASTIKA; WSN; MNLT; average node power; coalition routing.

1. INTRODUCTION

The combination of Distributed sensor nodes; which arranged inside the phenomenon or very close to it, is an emerging technology called as "Sensor Network". Sensor nodes sense data's from the local area and transfer it to the nearer node. Each node connects wirelessly with other local nodes through radio communication range. Every sensor has a microprocessor and a small amount of memory for sensing and communication purposes [13].

In present era WSN used in many different fields such as Environment monitoring, weather checking, Battle Field, Traffic control application. It can also be used in Agriculture field to monitor water level & Green House systems. Home automation, consumer electronics & security are another use of WSN.

Nodes of WSN generally operated by battery & the battery can supply power for a limited period of time. Power Consumption of wireless sensor network is a very challenging issue as each sensor network is equipped with a limited power source and the battery sometimes associated with the network can't be change after network in run mode, each battery associated to nodes are deployed before installation of the network. One node failure may cause total network trafficking failure hence cause the network failure. So battery power should be properly managed and proper algorithm needs to implement in WSNs which

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consume less power dissipation for traffic sending. Total power consumption of a network and average power consumed by node are prime parameters to extend lifetime of the network [12][13][14][19].

1.1. Wireless Sensor Network and its architecture design

After arranging a WSN we can't change the battery, which takes us to use the battery in an optimal way. To process data & to control the components of sensor node, microcontroller is used. A microcontroller is an intelligent choice for Embedded Architectures, it is flexible to connect to different systems & also ease to the program. Power consumption is very low in the microcontroller which is very important in wireless sensor network system. The followings are the key components of a node in wireless sensor network [19].

Transceiver: A transceiver is a device which works for both transmitting & receiving radio signals. ISM band is used by sensor nodes, which provide free radio spectrum allocation.

Power Source: Batteries are used to supply power to sensor nodes. As Power supply is limited, replacement or recharge is not feasible, it should be used efficiently. Embedded sensor nodes are generally consuming very less amount of power.

Memory: In an Embedded WSN Architecture flash memories are used. Two types of memory used in WSN "User Memory" used for storing application whereas Program memory used for programming the device[12].

Sensing Unit: A sensing unit in WSN formed by sensors & ADCs (Analog to digital converters). Generally, thesensor is an electronic device that detects thephysical presence of heat, light, sound, pressure and motion. After sensing sensor converts the physical presence into analog signals. This will lately convert into digital by ADC[13][19].

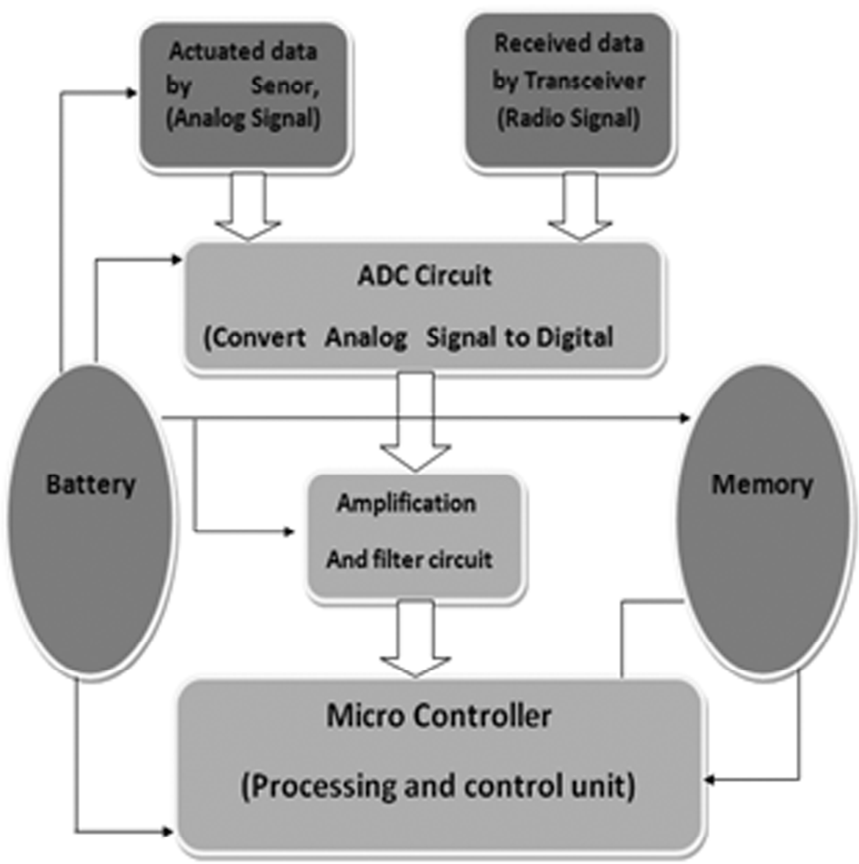

Figure 1: A right-facing swastika might be described as "clockwise" or "counter clockwise" .

1.2. Swastika

In this paper, we termed our model as SWASTIKA because our routing pattern resembling the Swastika. Swastika is a single word, not an abbreviation, which is an ancient religious symbol of Hindu. In Hindu religion, they have faith that swastika symbol route positivity and make everything efficient to any place like a house, working area, cultural area and society, it basically take a form of an equilateral cross, with its four limbs bent at 90^0[20].

1.3. Our Contribution

We have designed a routing path that is avoiding the high energy consuming path which follows the Dijkstra to find the next node to send traffic, until the destination has reached. instead, we are following an adaptive routing techniques for that high energy consuming path which are basically the diagonal path to any uniformly distributed network, which enhance the network total power consumption hence, leads to early battery discharge. To deal with that we use to rout the diagonal path in an orthogonal direction directed towards the destination, which can be treat as the second shortest distance routing for the node which generally follow the diagonal path. Shortest path algorithm Dijkstra [1] use to find out the next node to which route should be done to send the traffic so as to reach the destination. In that way, we prepared an adaptive coalition routing which has been effective in terms of total power consumption and the average per power consumption by a node. As a result the battery last for long which implies the maximization of the network lifetime. The routing path is such that it looks like a swastika, the ancient symbol of Hinduism for all scale of nodes so, we named this anonymous routing as swastika. This swastika can be clockwise or it could be antilock wise, depending upon the network usability, both giving the same total power.

2. PRELIMINARY AND LITERATURE SURVEY

In reference [1] authors Ratul K. Guha and his team have proposed a fair routing keeping interest of node to share the resource in their mind by proposing a better condition for routing which they stated as fair coalition routing for group sharing by use of distributed algorithm. DipakWajgi et al[2], they have surveyed different algorithm to balance the node in a network where they have found that the load balancing can cause the lifetime of the network maximum. They also sight on the area of network reliability which also can be possible by balancing the load. From the survey they have found that increase network scalability also can possible through load balancing by clustering them. SumanMor et al.[3] have given an idea regarding how uneven distribution of sensor node leads to hole formation in a network, contrary that how spreading the load in each sensor evenly enhances the network lifetime. They have analyzed a different algorithm to balance the node and applied different distribution techniques to distribute the load in a wireless sensor network. DipakWajgi et al[4] have focused on how to reduce the load on the node, to balance the node by using clustering techniques through less consumption of energy, in this paper they have proposed a clustering algorithm which will balance the node’s load by using some backup nodes which will replace the cluster head after the cluster reach the threshold limit which provides high throughput to the network. Chor Ping Low et al[5] have proposed clustering algorithm to balance the node and specified the load balancing clustering problem by selecting few nodes as the cluster head which will act as a gateway and called them gateway nodes which balance the load among those gateways. They have also done the investigation that their load balanced clustering problem is NP-hard. Mina Mahdavi et al[6] have stated in context to load balancing in wireless network sensor that a wireless sensor network can be successfully operated if both connectivities of network and coverage of sensing met, they have studies simultaneously both coverage and connectivity problems for a wireless sensor network. Yaping Deng et al[7], team have proposed a protocol named as LBGC, load balancing group clustering where they have selected the cluster head periodically and the route calculation they have done dynamically in according to the energy distribution on the network in context to a heterogeneous wireless sensor network. Han Zhang et al[8] have proposed an approach to gather data in a wireless sensor network using load balancing where the weight value depends on two-factor, one the distance between the heads and another is the energy of members and residual energy which further deal with optimization of the threshold to improve the span of the network. Ming Ma et al[9], this group has worked on a hybrid sensor network which has two layers, a lower layer form by a cluster of sensor nodes and the upper layer is collected the sensing data by the sensor and send them to the observer outside. They have calculated and estimated the different way to balance the node, scalability and how to maximize network lifetime, by simulating in NS-2 they have attained thirty-five percent network lifetime hike. M. A. Matin and M.M Islam [10] have given the basic concept regarding the design and working principle of the sensor node and how the nodes communicate each other, sighted on the different challenges in a wireless sensor network. Swati Sarma and Pradeep Mittal [11] have surveyed the different factors of wireless sensor network, regarding issues related to design, the power associated and mobility, capabilities for communicating, apart from this in this paper they have sighted different design issue related to network and elucidate the different protocols and explore the different research issue for the network realization. K. Das et al.[12] have tried to design a network model by excluding the heavy loaded node from the conventional routing model and later they have theoretically calculated the variance of consumed power among nodes in a wireless sensor network, from the result they have got will ensure to be improving the lifetime of the network. Basically, they have excluded the node whose average power they have found maximum which is increasing the total power consumption in that particular network and they have found the approach is been best to implement keeping interest on network lifetime enhancement. K. Das et al.[13] also, design another model where they have used to route the traffic in selected nodes and in this proposed model they have routed the traffic differently than to conventional method to avoid load on the node in context to minimize battery power use, hence to increase the network lifetime of the wireless sensor network.

3. THE MATHEMATICAL POWER MODEL

3.1. Power Model

A node power consumption (PC) in the WSN is directly proportional to d^x, where 'd' is the distance between the source node to next targeted node and x is a varying environmental factor which is depend on the light intensity and interference level around the deployed nodes in a network and which vary from 2 to 6. In our case we, have taken the value of x is 4, themid value so as to study the performance of SWASTIKA in a steady environmental condition. Generally for small distance or free space model we are taking the value of x is 2 and for long distance or shadowing model we are taking the value is 6. We can say the value of x lie can be taken within the range $2 \le x \le 6$, for our model we have taken $x = 4$ (standard)[1][2][3][4][5].

PC is directly proportional to the rate of outgoing traffic r from the node and PC is also directly proportional to d^x [2], [7], [8], [9].

$$\text{PC} \ \alpha \ r$$
$$\text{PC} \ \alpha \ d^x$$

By equating the relationship

$$PC = K \times r \times d^x \tag{1}$$

Where the dimension of K is μW/M bit × m^4 [1], and is a constant.

Unit of PC = (μW/M bit × m4) × (Mbps) × (m4) = μW/sec

TPC is the total power consumption in the network and is given by equation (2)

$$TPC = \sum_{1}^{N} PC_i \tag{2}$$

The Average Power Consumption (APC) is the mean of PC

$$APC = TPC/N$$

By using equation (2) APC can be represent in terms of node power consumption,

$$APC = \frac{\sum_{1}^{N} PC_i}{N} \quad (3)$$

3.2. Network Model

In this paper, for our calculation we have taken the scale of the node starting from three. i.e scale 'Ω'= 3,5,7……, for to evaluate our proposed model we have taken the 'Ω' up to 15 for both conventional routing method models which follow intrinsic Dijkestra algorithm for routing with the SWASTIKA model which follow adaptive routing techniques which reconfigured the highly loaded path into low loaded routing. In SWASTIKA sending the traffic from node to sink is following power aware routing where the orthogonal path to sink are given preference over the diagonal path from node to sink. As a result of which a heavy fall in total power consumption in external circuit takes place, which ensure an enhancement in network lifetime.

Our conventional model is based on the Rutul K. Guha[1], where he follow the shortest path to send traffic from one node to another until the packet reached to destination. Each node generate a uniform 1 Mbps data rate to communicate each other. The total traffic is carried out based on the coalition routing among the nodes.

3.3. 3 × 3 model designed ('Ω' = 3, N = 9)

Here K = 1 and r = 1 Mbps and the value of x which is depending on environment, here taken as 4 (assuming the network for both conventional and SWASTIKA exposed to the same environmental condition). The node distribution for the conventional routing as shown in Fig. 3

The same network can be redesigned into SWASTIKA by changing the high loaded diagonal path into orthogonal low loaded path, here in Fig. 3. Node number 1, 3, 7 and 9 are having high load i.e 4 and are shown in the Fig. 2.

The graph showing SWASTIKA implantation model of the conventional model with minimum total power consumption and minimal node power consumption. This could of either type one clock wise and another is anticlockwise SWASTIKA. For every scale both of SWASTIKA is possible, this is been another advantage of SWASTIKA that the routing path in the network is not static.

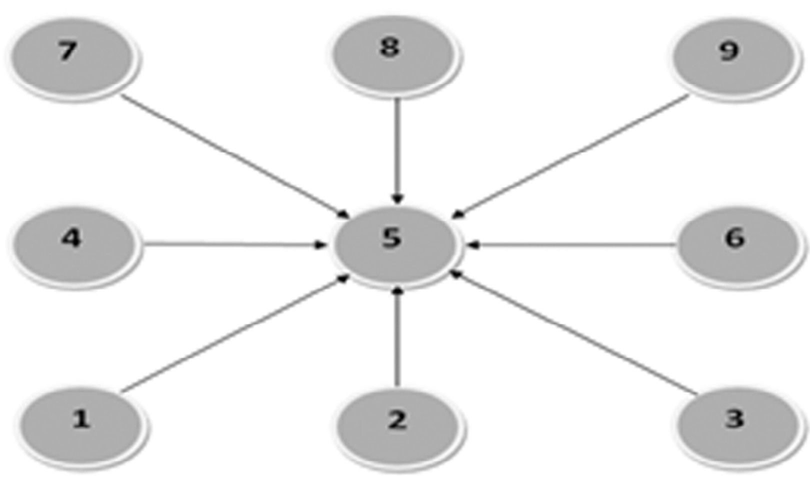

Figure 2: Conventional routing with Scale 3 and centre at node 5

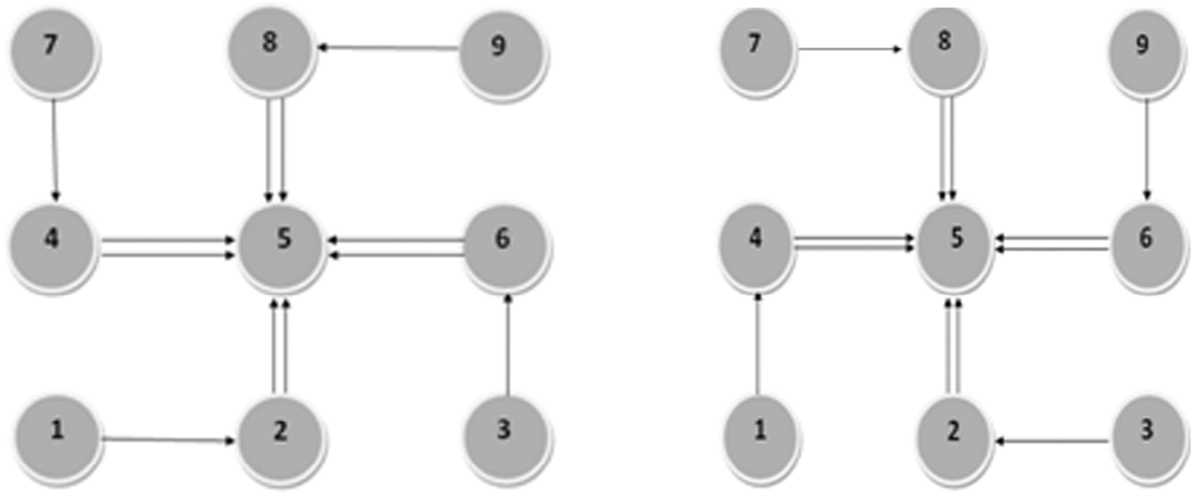

Figure 3: A right –facing swastika might be described as "clockwise" or "counter clockwise".

For conventional model with scale 3 × 3, The 1 node PC = 4 μW/Sec, 2 node PC = 1 μW/Sec, 3 node PC = PC 4 μW/Sec, 4 node PC = 1 μW/Sec, 5 node PC = 0 μW/Sec (center), 6 node PC = 1 μW/Sec, 7 node PC = 4 μW/Sec, 8 node PC = 1 μW/Sec, 9 node = 4 μW/Sec. The total power consumption (TPC) by applying equation number (4),the output value is 20 μW/Sec.

For Clockwise- SWASTIKA model with scale 3 × 3, The 1 node PC = 1 μW/Sec, 2 node PC = 2 μW/ Sec, 3 node PC = PC 1 μW/Sec, 4 node PC = 2 μW/Sec, 5 node PC = 0 μW/Sec (center), 6 node PC = 2 μW/Sec, 7 node PC = 1 μW/Sec, 8 node PC = 2 μW/Sec, 9 node = 1 μW/Sec. The total power consumption (TPC) by applying equation number (4), the output value is 12 μW/Sec.

3.4. 5 × 5 model designed ('Ω' = 5, N = 25)

Similarly, The same network can be redesigned into SWASTIKA by changing the high loaded diagonal path into orthogonal low loaded path, here in Fig. 5. Node number [1 2 4 5 6 7 9 10 16 17 19 20 21 22 24 25] are following through high load routing path, which is rate of traffic multiplication of i 4 μW/sec and are shown in the Fig. 5.and calculation of the total power for both the node has been done taking equation 1, 2, 3 and the result is been tabulated in the table number 1.

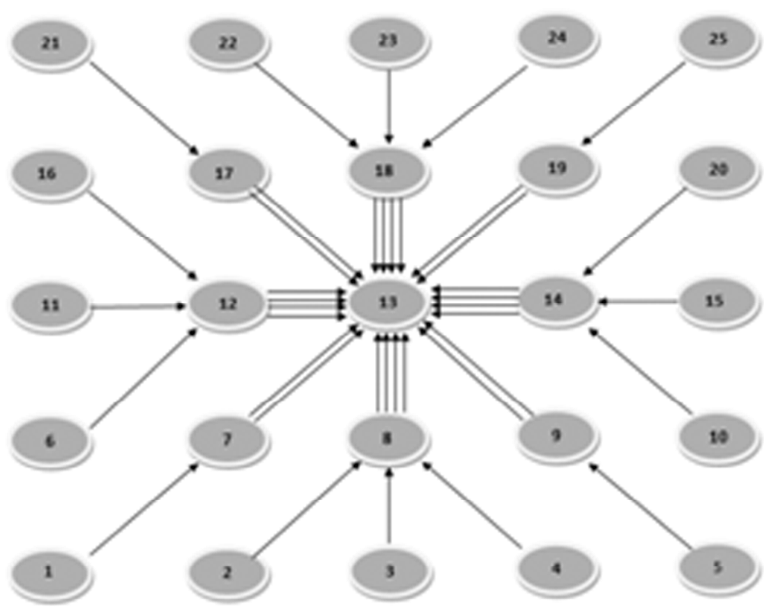

Figure 4: Conventional 5 × 5 coalition routing model based on shortest path routing (Dijkestra algorithm)

For conventional model, The 1 node = PC 4 μW/Sec, 2 node = PC 4 μW/Sec, 3 node = PC 1, 4 node = PC 4, 5 node = PC 4, 6 node = PC 4, 7 node = PC 8, 8 node = PC 4, 9 node = PC 8, 10 node = PC 4, 11 node = PC 1, 12 node = PC 4, 14 node = PC 4, 15 node = PC 1, 16 node = PC 4,17 node PC 8, 18 node = PC 4, 19 node = PC 8, 20 node = PC 4, 21 node = *PC* 4, 22 node = PC 4, 23 node = PC 1, 24 node = PC 4, 25 node = PC 4. The total power consumption is 100 μW/Sec.

The total power of standard 5 × 5 conventional model is calculated and the value is 100 μW/Sec. which we tried to minimize using our adaptive routing in SWASTIKA model shown in the figure no 6.

For Clockwise-SWASTIKA model, For conventional model The 1 node = PC 1 μW/Sec, 2 node = PC 2 μW/Sec, 3 node = PC 4, 4 node = PC 1, 5 node = PC 1, 6 node = PC 1, 7 node = PC 1, 8 node = PC 6, 9 node = PC 1, 10 node = PC 2, 11 node = PC 4, 12 node = PC 6, 14 node = PC 6, 15 node = PC 4, 16 node = PC 2, 17 node = PC 1, 18 node = PC 6, 19 node = PC 1, 20 node = PC 1, 21 node = PC 1, 22 node = PC 1, 23 node = PC 4, 24 node = PC 2, 25 node = PC 1. The total power consumption is 60 μW/Sec.

IV. IMPLEMENTATION

We have implemented the different scale starting from the 3(having node 9) to 15(having node 225) and calculate the node power consumption using the equation. (1), and subsequently the total power consumption (TPC) and the Average Power Consumption (APC) from the equation number (2) and (3) respectively. And the resultant value for the conventional model is tabulated in table no. 1.

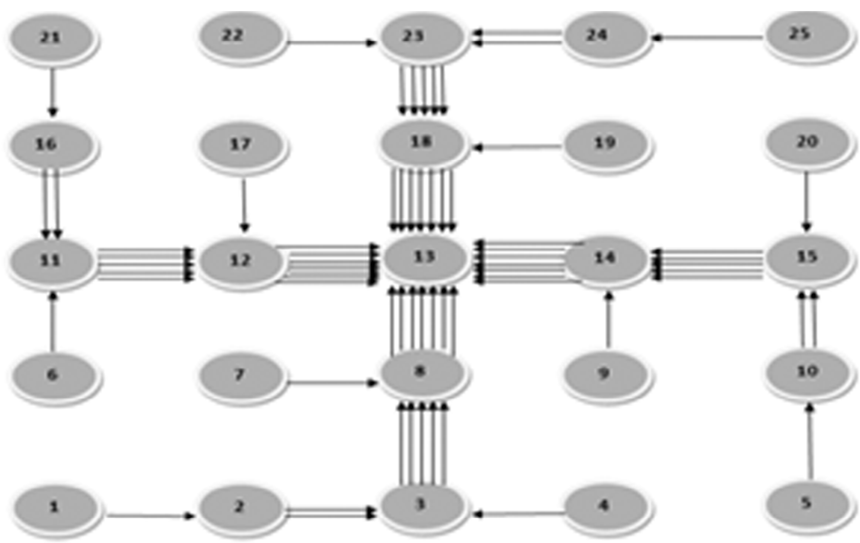

Figure 5: Conventional 5 × 5 coalition routing model based on shortest path routing (Dijkestra algorithm)

Table 1
Tabulation of different total nodes and TPC and APC with respect to different scale/size of the WSN for Conventional Model

Sl. No	*Scale*	*Total Node*	*Total Power*	*Power Consumed Per Node()*
1	3	9	20	2.2
2	5	25	100	4
3	7	49	280	5.7
4	9	81	600	7.4
5	11	121	1100	9.0
6	13	169	1820	10.7
7	15	225	2800	12.4

The TPC, PC and the APC has been tabulated from the output of the simulated result in MATLAB. The Table I. holding the total power consumption and average power consumption per node for conventional model with the different scale, hence for different size and the above parameter has been tabulated in Table II for proposed SWASTIKA model. And the characteristic graphs is drawn in Fig. 7.

The figure 6 is drawn from the simulated result for SWASTIKA model whose value is tabulated in Table II, showing the total power consumption and the prescriptive (conventional model)with respect to the different size of the network and different scale value.

In the above graph, we have plotter all the magnitude of TPC of different cluster having different nodes present by using SWASTIKA model for routing the traffic.

Fig 7. Is a plotted bar graph between the conventional model's Average Power Consumption to the SWASTIKA model's Average Power Consumption and from the graph it is clearly visible that the SWASTIKA model per node PC is much less as compare to the conventional model per node PC.

In figure 8 a comparison graph has been drawn in Matlab from the simulated Total Power Consumption (TCP) data of both conventional model and of SWASTIKA with respect to increasing scale and size of the network and from the graph it is clearly visible that the green line progress with PC magnitude of swastika is quite low compare to the conventional TPC.

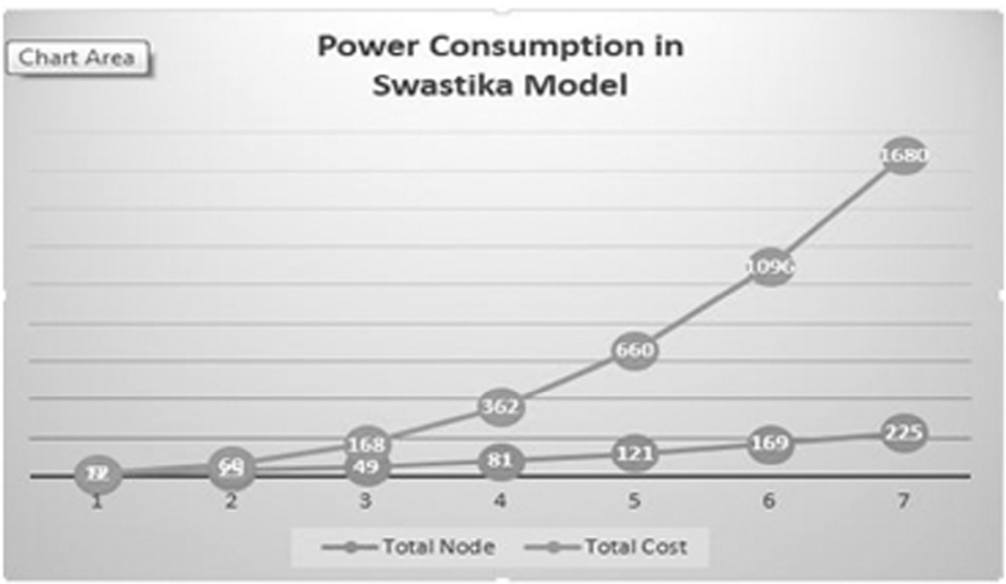

Figure 6: Conventional 5 × 5 coalition routing model based on shortest path routing (Dijkestra algorithm)

Table 2
Tabulation of different total nodes and TPC and APC with respect to different scale/size of the WSN for SWASTIKA Model

Sl. No	*Scale*	*Total Node*	*Total Cost*	*Cost Per Node*
1	3	9	12	1.3
2	5	25	60	2.4
3	7	49	168	3.4
4	9	81	362	4.4
5	11	121	660	5.4
6	13	169	1096	6.4
7	15	225	1680	7.4

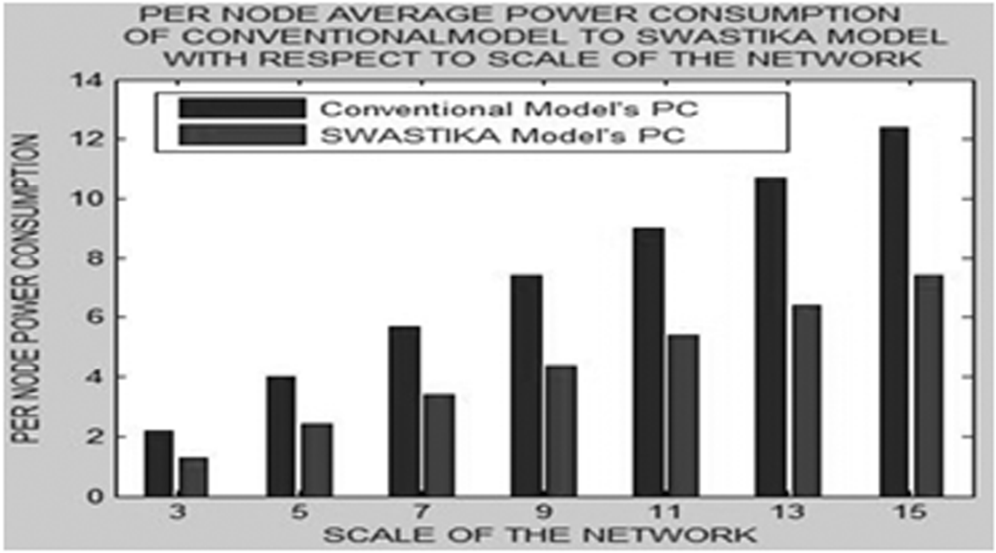

Figure 7: per node Average Power Consumption (APC) comparison bar graph between conventional models to SWASTIKA model

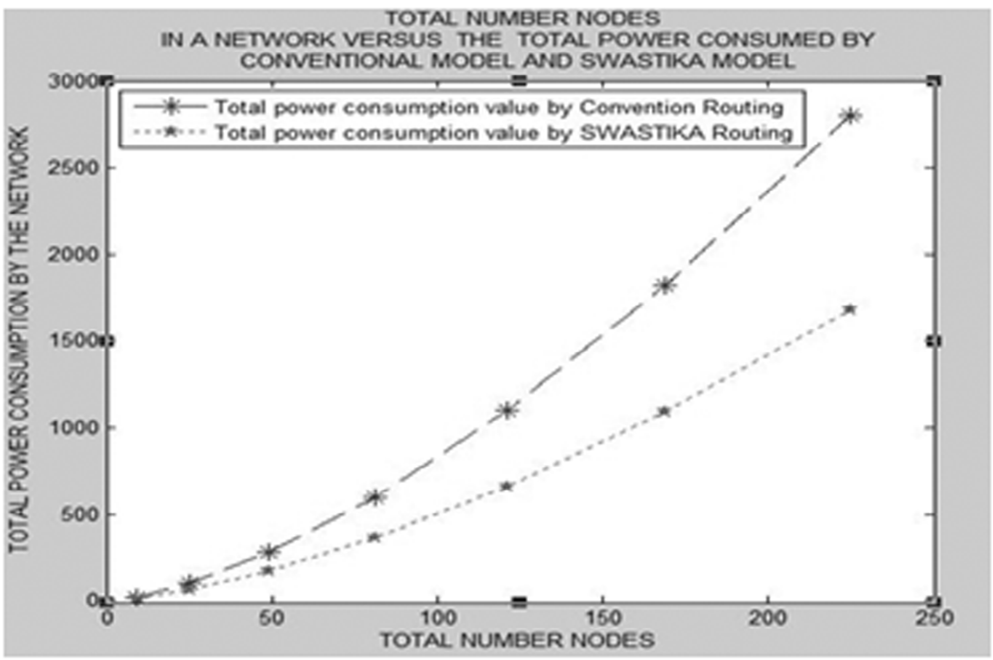

Figure 8: Total Power Consumption (TPC) comparison bar graph between conventional models to SWASTIKA model

5. CONCLUSION

In our approached adaptive coalition routing in SWASTIKA model we can able to minimize power consumption of node, also for the total power consumption of the network and the average power consumption of each node at different scale/size of the wireless sensor network. In our approach we have been succeeded to balance the load on the node by minimize the average power consumption on load and to have a power aware routing. Which ensure an enhancement in the lifetime of the WSN with a huge margin in SWASTIKA model approach over the Conventional model approach.

In future we would like to further minimize the TPC and APC by using the Swastika model, that will reconfigure to form a interlock model by use of clockwise and anticlockwise SWASTIKA model for a large WSN by forming clusters, which will further maximize the network lifetime.

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