SUITABLE ENERGY ADVANCEMENT IN DIRECT AND MINIMUM TRANSMISSION APPROACHES

Saumya Dubey[1], Sonam Singh[2], Vandana Upadhyaya[3], Ram Krishna Sharma[4]

[1,2,3,4] Department of Electronics & Communication Engineering, UIT, Allahabad (India)

ABSTRACT

Direct transmission energy approach explains that the nodes which are at the maximum distance from the sink died first. Unlike the previous, minimum transmission energy approach explain that the node nearest to the sink node died first. This theory concludes that there is no any strict requirement of energy advancement in the former since all nodes send data directly to the sink. In later, due to multi-hop propagation of data, one node depends on others state (on/off). Another important fact is that the nearest node to the sink dies first; therefore nodes near to the sink in this approach require more energy to run this protocol properly. If it does not happen, self configurable nodes are required to change their configuration as the distance between nearest node and sink changes.

Keywords: Network Life Time, Energy Consumption, Advancement in Sensor Nodes

I. INTRODUCTION

Wireless sensor network is the connection of a huge number of sensor nodes through a wireless medium is a self-organization (Ad-hoc) distributed network system. [1] This has large applications in military surveillance, environmental monitoring, seismic and weather forecasting, disaster relief, underground, deep water and outer space exploration and other areas as required. The network basically only monitors the event occurring at a place but it cannot be used in controlling the same. The information collected to the user results for the type of a control action. The deployed nodes collect the data and send it to the sink using any defined approach. The data is then transferred to the user through the satellite or internet and then broadcasted if it is required. Since nodes are battery powered devices and deployed at the place where battery cannot be either replaced or recharged, therefore energy efficient approaches are required to increase life time of the network. Hence the radio should be switched off as soon as there is no more data to send/receive, and should be resumed as soon as a new data packet becomes ready. In this way nodes alternate between active and sleep periods depending on network activity. This behavior is usually referred to as duty cycling. [2]

II. RELATED WORKS

The sensor nodes have RF transmitters and Receivers (Antennas), ADCs and DACs, processing unit (Microprocessors or microcontrollers), and external memory. Antennas receive RF data to convert it into analog electrical information which is then processed and converted to digital data using ADC. This data is used by the processing unit. The processed digital data is converted then to analog electrical information which is then sent through the transmitting antenna. For comparing the two different protocols in the same environment, we neglect the energy consumption by the above components of the nodes. The energy consumption of these blocks is same for both the protocols. Hence we want to calculate energy consumption using only routing techniques. [4]

The radio module can be explained as follows:

The receiver and transmitter circuits consume energy in equal amount. The transmitter amplifier consumes excess energy to strengthened data so that the information is being capable of reaching at the receiver of another node successfully. [5, 6] The basic concept behind this theory is the concept of friss loss in wireless medium which explains that the strength of a signal in wireless medium decreases as the distance increases.

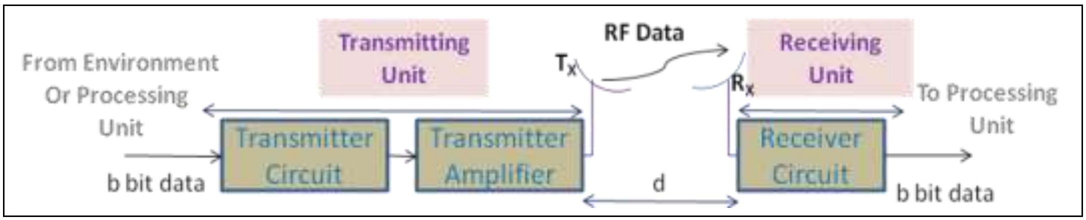

Fig. 1: Radio Module in A WSN

The radio module also explains that the energy consumption due to receiving circuit is not applicable if data is not received by the receiving antenna but it is gathered via sensors connected for suitable applications and requirements. The radio module (in Fig. 1) explains following energy consumption in a WSN:

Energy consumed by the receiver section $E_{RX}(b,d) = bE_{elec}$ ……………………………………………. (1)

Energy consumed by the transmitter section $E_{TX}(b,d) = bE_{elec} + bE_{amp}d^2$ ……………………………... (2)

'b' is the data bits to be transmitted, 'E_{elec}' J/bits is the energy consumption by transmitting as well as receiving circuits, 'E_{amp}' J/bits-m^2 is the energy consumption per bit per meter square distance. 'd' is the distance between two consecutive nodes for which the radio module is explained.

Since friss loss is inversely proportional to d^2, therefore E_{amp} is directly proportional to d^2.

In Direct Transmission Energy Approach; [3] the sensor nodes directly send their data to the sink without any involvement of other sensor nodes. This approach is known as single-hop approach. Since all nodes sense environment and gather information accordingly therefore their receivers are switched off permanently. If distance between two consecutive nodes is r then n^{th} node consumes energy equal to the transmission energy for distance equal to **'nr'** as shown in Fig. 2 (at next page). Hence total energy consumption by n^{th} node of the network,

$E_{TX}(b,d) = 0 + bE_{amp}d^2 = bE_{amp}d^2 = bE_{amp}(nr)^2$ ………………………………………………………. (3)

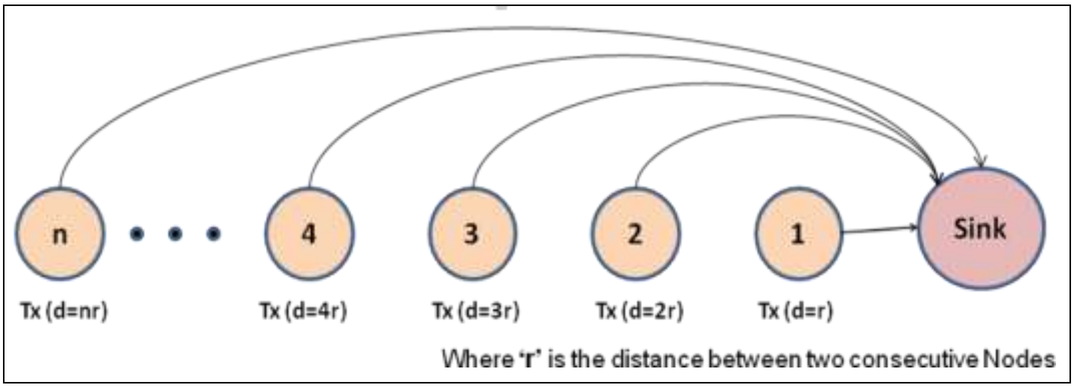

Fig. 2: Direct Transmission Energy Approach

As distance of the node from the sink increases in direct transmission energy approach, the energy consumption of that node also increases from equation (2). If initial energy of all the batteries is equal, n^{th} node will die first.

In minimum transmission energy approach; [3] information is sent node to node. This is also called multi-hop propagation. In this approach it is clear that the n^{th} node does not consumes energy for receiving any data as it only collects data from environment through the sensor. The next node receives that data and sends it to next one addition with the data collected from the environment. Hence n^{th} node consumes energy following equation (2).

For n^{th} node; $E_n(b,d) = (0R_X + 1T_X) = bE_{elec} + bE_{amp} r^2$ ………………………………………………………. (4)

For $(n\text{-}1)^{th}$ node; $E_n(b,d) = (1R_X + 2T_X) = 3bE_{elec} + 2bE_{amp} r^2$ ……………………………………………. (5)

Hence for first node; $E_n(b,d) = ((n-1)R_X + nT_X) = (2n-1)bE_{elec} + nbE_{amp} r^2$ ……………………...…… (6)

From the above theory, it is clear that the nearest node will die first and the furthest node will die at last. This is shown in Fig. 3. This situation is slightly complex as the nearest node die, the second nearest node must be communicate directly to the sink otherwise no data will reach to the sink while (n-1) nodes are alive.

This complexity can be removed only by dynamic configuration of the nodes.

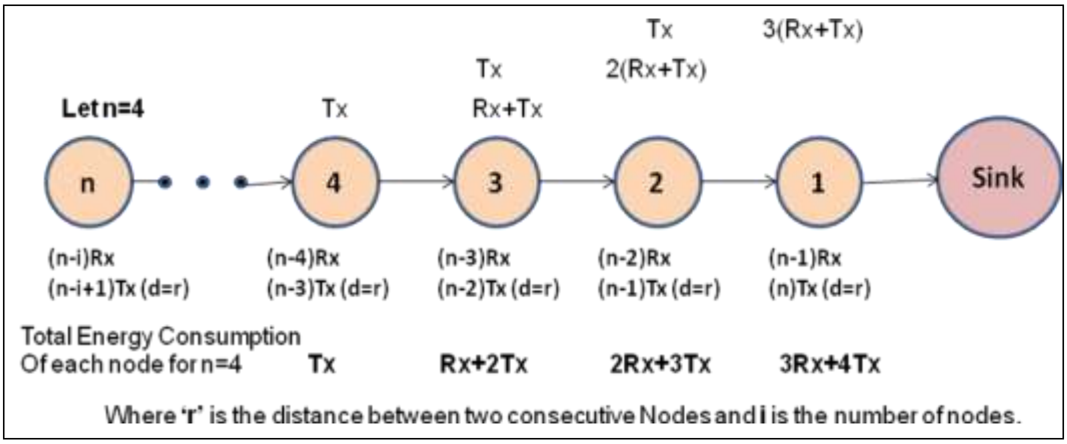

Fig. 3: Minimum Transmission Energy Approach

As the first node dies, the second node must communicate to the sink. As the second node die, third node must communicate to the sink and so on.

If n^{th} node gets data from the environment and no other nodes get then the total energy consumption in WSN will be equal to the summation of (n-1) time's energy consumption by unit receiver and n time's energy consumption by unit transmitter. Hence energy consumption in this case will be equal to $(2n-1)bE_{elec} + nbE_{amp} r^2$. This energy is equal to the energy consumption by first node when all nodes get data from environment.

III. WORK DONE

The above two approaches show that the minimum energy transmission approach is slightly complex than that of direct transmission approach which is very simple in action and also in algorithm. In such cases advancement in the network is required. If we can increase the energy of those nodes that are going to die first then they will operate with all other nodes. Summary is the life time of those nodes will increase up to the mark. These nodes can be 10%, 20%, 50% etc. This is very helpful in minimum transmission energy approach as this use multi-hop technique and nearest node dies first in this case.

IV. SIMULATION AND VERIFICATION OF RESULT

Let, E_{amp} =100x10^{-12} J/m^2-bits, E_{elec} =50x10^{-9} J/bits, N=1000 nodes, b =2000 bits/sec, D=2000 meter.

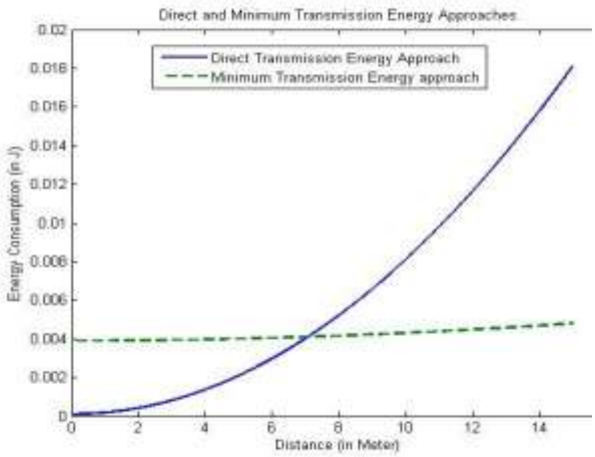

Fig. 3: Comparison for nth Node

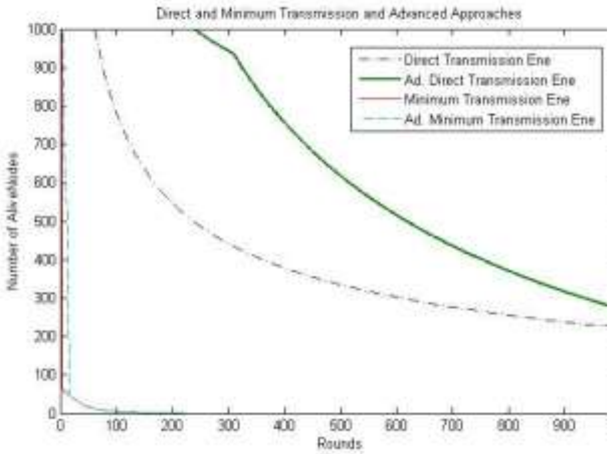

Fig. 4: Comparison for whole Network

Fig. 3 shows the plot comparison of Direct and minimum transmission energy protocols. This is done for the nth node (outermost node) and combines energy consumption by all the nodes when only nth node get data from environment and other nodes have their receiver switched off. There is always a distance where both the approaches consume equal energy. This distance can be described as

$$r_{equal} = \frac{r^2 n}{2} \quad \ldots\ldots (7)$$

Below this distance, direct transmission approach is better than minimum transmission approach as shown in plot.

Fig. 4 shows the energy advancement and it is clear that if advanced nodes are placed at suitable positions in the network then it is very useful. The diagram also shows that the energy advancement is always better than its normal approach.

The project is verified using simulation software (MATLAB 2011b).

V. CONCLUSION AND FUTURE SCOPE

This analysis shows that the energy advancement is always better than the normal of its approach. Direct transmission approach consumes less energy than that of minimum transmission energy approach below a certain distance. Future protocols will always simulate for the nodes deployments with very low distance between them. Therefore, direct transmission approach is useful in future protocols and analysis.

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