MODIFIED-LEACH ALGORITHM FOR ENERGY EFFICIENT ROUTING IN WIRELESS SENSOR NETWORKS

[1]Author- Doddavarapu Sreenu Babu, [2]Author- Dr. Vijay Prakash Singh.

[1]Author: Scholar at ECE department and [2]Author: Professor at ECE department in Sri Satya Sai University of Technology & Medical Sciences-Sehore-MP

ABSTRACT

Wireless Sensor Networks are usually composed of a lot of distributed sensor nodes that organize themselves into a multi-hop wireless network. Several of the main problems in wireless sensor networks are actually energy usage, lack of authentication data integrity as well as instability of load link between sensor nodes which brings down the acceptance of the sensor network. The latest communications in wireless sensor networks (WSNs) have a lot of new energy-efficient protocols especially designed, in which energy recognition is actually an important concern. Inside WSNs, many small sensor nodes are utilized as a good means of data collecting in a variety of environments. Since the sensor nodes run on the battery of power that is restricted, it's an excellent demanding goal to develop an energy-efficient routing protocol, which may lessen the delay while providing long span and high energy efficiency of network lifetime. Our proposed item is actually improved from LEACH protocol by adapting node scheduling program (active and sleep) in heterogeneous and homogeneous node topologies of WSNs, which yield better performance in energy saving and then improved network lifetime. The work carried out is presented in this thesis will be based on simulations of newly designed routing protocols, from the key routing protocol of clustering based hierarchical, routing protocol namely called LEACH (Low Energy Adaptive Clustering Hierarchy). Simulations allow for more aspects to be evaluated and more parameter values to be investigated, than what would be possible using real applications in real wireless sensor networks. Nevertheless, the accuracy of every simulation is dependent on the accuracy of the simulation models used in the developed routing protocols

Keywords *- Leach Algorithm, Energy Efficient Routing, Wireless Sensor Networks, energy efficiency etc.*

1. INTRODUCTION

A WSN consists of a setup of sensor nodes/motes which perceives the surroundings under monitoring and transport the information through wireless links to the Base Station (BS) or even sink. The sensor nodes might be homogeneous or heterogeneous and might be stationary or mobile. The information gathered is actually forwarded via single/multiple hops to the BS/sink. The basic framework of a WSN device is depicted in Figure 1.

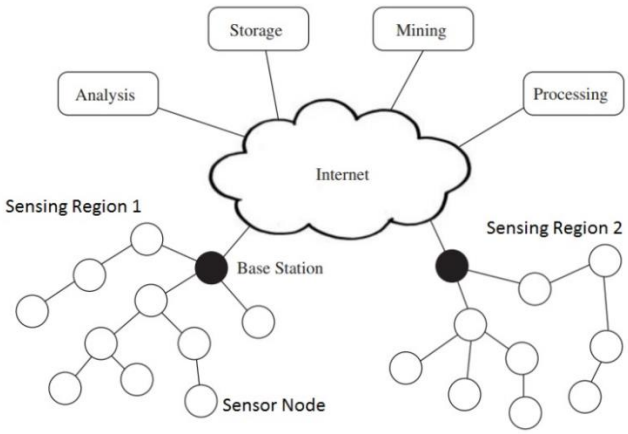

Figure 1: Framework of Wireless Sensor Network

1.1 Classification of Wireless Sensor Networks

Wireless Sensor Networks are incredibly application certain and are deployed based on the demands of the application. Hence, the qualities of one WSN will change to that of another WSN.

Regardless of the application, Wireless Sensor Networks on the whole could be classified into the coming categories.

- Static and Mobile WSN
- Deterministic and Nondeterministic WSN
- Single Base Station and Multi Base Station WSN
- Static Base Station and Mobile Base Station WSN
- Single-hop and Multi-hop WSN
- Self – Reconfigurable and Non – Self – Configurable WSN
- Homogeneous and Heterogeneous WSN

1.2 Kinds of Wireless Sensor Networks

According to the planet, the forms of networks are actually resolved to ensure that those may be deployed underwater, underground, on land, etc. Various WSNs types include:

1. Terrestrial WSNs
2. Underground WSNs
3. Underwater WSNs
4. Multimedia WSNs
5. Mobile WSNs

A number of sensors will be integrated into the WSNs depending on the application requisite. The WSNs generally does not have some infrastructure; it could be structured or perhaps unstructured. The sensor nodes possess restricted source of energy and also processing as well as mind abilities. A radio is actually applied for communicating the sensed facts to the BS and then on to the user. Energy supply of sensor nodes is actually battery. Energy harvesting methods are usually from time to time leveraged for charging the battery. The small scale of the sensor nodes facilitates to embed these sensor nodes easily in any gear or perhaps in virtually any setting quickly. Due to this particular feature WSNs discovers astounding use in checking as well as monitoring uses in several areas.

2. LITERATURE REVIEW

F. Ahmed et al., (2019) Lots of recent Wireless Sensor Network (WSN) routing protocols are actually enhancements to deal with particular problems with the Low Energy Adaptive Clustering Hierarchy (LEACH) protocol. Since the overall performance of LEACH deteriorates sharply with raising network size, the struggle for new WSN protocols is actually extending the network lifespan while keeping high scalability. This particular paper introduces an energy efficient clustering and hierarchical routing algorithm named Energy Efficient Scalable Routing Algorithm (EESRA). The objective on the suggested algorithm is actually extending the network lifespan even with a growth in network size.. The paper compares EESRA against many other WSN routing protocols in phrases of network performance with regard to changes in the network size. Simulation results show EESRA outperforms the benchmarked protocols in term of ton balancing as well as energy efficiency on big machine WSNs.

Chan et al., (2015) Energy efficiency is regarded as the demanding subject in Wireless Sensor Networks (WSN). Due to the increasing needs of different programs, as well as the constraints of energy, computational power and mind of the WSN nodes, numerous research has centered on these places recently. Scientists have suggested a selection of protocols like LEACH, TEEN, HEED, PEGASIS, etc. With this paper, we are going to discuss exactly how energy efficiency is actually impacted by scaling, i.e. various network sizes, and by various routing algorithms. With all the increasing uses of large scale WSNs, for example environmental monitoring as well as smart grid.

Alhasanath (2014) proposed an innovative data collecting algorithm known as connectivity-based data collection in which the sensor node connectivity is actually utilized to uncover MS path. Lowering the number of multiple hops was additionally a key problem. The simulation outcomes of the comparison of the brand-new technique with LEACH algorithm shows that the proposed algorithm prolonged the network life time.

Mahmood et al. (2013) modified LEACH by introducing a different CH replacement scheme and dual transmitting power levels. The functionality of the revised MODLEACH was evaluated depending on the parameters as throughput, development of

lifetime and CHs, keeping soft and hard thresholds. The primary goal of all of the enhancements of the LEACH protocol is actually increasing the energy efficiency.

Zhao et al. (2012) proposed an enhancement of LEACH by introducing sub CHs to control the circumstance of absence of the CHs. They compared the overall performance of the revised technique with LEACH via simulation. The tests demonstrated that the proposed strategy is enhanced in phrases of power use and lifetime.

3. PROPOSED METHODOLOGY

Energy efficiency is actually regarded as to be the most crucial issue in wireless sensor networks. You will find many methods to enhance the energy efficiency, which subsequently maximizes the lifetime of the network. Energy successful routing is actually among the most prominent methods to minimize the energy usage of the sensor nodes. Along with different kinds of routing, hierarchical routing has received significance from the research group.

Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is actually the very first hierarchical clustering technique of WSN. In the LEACH protocol, the network is actually partitioned into clusters. Each round of performance consists of 2 phases specifically the setup as well as the steady state phase. In the Setup phase, the cluster is actually created as well as the cluster heads are actually elected depending on the predefined percent of the amount and cluster heads of times the node continues to be a cluster head in the prior rounds. In the constant state phase, the information is transmitted to the base station. Following conclusion of each round, re-clustering takes place. Nevertheless, LEACH protocol isn't ideal for region networks that are big when the uneven division of the cluster heads bring additional overhead. Yet another leading drawback is energy nodes that are lower may additionally be elected as cluster head. This results in node disaster and as a result, network partitioning takes place. To conquer the downside of LEACH protocol, a Modified LEACH algorithm is suggested to this specific chapter. The functionality on the Modified LEACH algorithm is actually in contrast to the LEACH and Adhoc On Demand Vector (AODV) routing protocol.

Inside WSN, hierarchical based energy efficient routing is regarded as to be the best technique for energy conservation. With this section, several of the prominent works depending on Clustering is talked about. A U- LEACH routing protocol is suggested to uniformly disperse the cluster heads through the network. Since LEACH protocol arbitrarily elects cluster heads, a number of nodes in the network doesn't have some cluster heads in the vicinity of its. The proposed U-LEACH protocol utilizes a Uniform Distribution Technique (UDT) for choosing the cluster heads as well as the clusters of theirs. Nevertheless, the residual energy of the nodes isn't considered in this particular strategy, which subsequently elects energy nodes that are poor as cluster heads in consecutive rounds of operation.

The authors proposed an energy efficient routing protocol named Data Aggregation based Optimal LEACH (DAO-LEACH) to improve the network longevity. The cluster heads are actually elected based on residual energy as well as information aggregation is actually performed to minimize the quantity of information transmitted. Additionally, energy efficient paths are actually elected to forward the information with the bigger energy nodes. DAO-LEACH isn't ideal for big networks as it doesn't think about the distance for routing that leads to higher correspondence expenses. Since the information is forwarded via night haul routing paths, energy use is actually enhanced to the network.

A weighted LEACH (W-LEACH) algorithm is suggested depending on the centralized information aggregation method. Each sensor is actually assigned a weight depending on the remaining energy as well as the density of neighboring nodes in the range of its. The sensor having more importance is actually selected as the cluster head. Nevertheless, there aren't any secondary heads to share the load of the main head. A Q-LEACH algorithm is actually suggested, in which the network is actually partitioned into 4 quadrants. The cluster heads are identified in the best possible positions. The cluster members select their clusters based on the RSSI worth in the advertising campaign message. Nevertheless, the cluster heads are actually picked arbitrarily without thinking about the residual energy of the nodes.

The majority of the prominent works depending on the LEACH protocol have less significance on the residual energy as well as distance of the cluster heads. The algorithms concentrate on the energy usage of the nodes throughout the transmission of information and extremely less focus are provided to the energy allocated to network construction. To do this, the Modified-LEACH algorithm is suggested to

this specific section.

3.1 System Model

Assumptions

The coming assumptions are believed to be for the proposed algorithm:

- The sink and sensor nodes (base station) are actually static in nature.
- Sensor nodes are arbitrarily deployed to the network discipline.
- Sensors are homogenous and also have exact same abilities.
- Sensor nodes are actually battery powered and can easily calculate their very own residual energy.
- Each and every node has a distinctive id as well as local information about its neighbor nodes.

3.2 Network Model

A wireless sensor network is considered with a set of nodes V_n and a sink node. Each sensor node V_n (i=1….n) has the location information (x_i,y_i). The sink node has limitless memory, processing capability as well as battery power. The sink node has the identity as well as location of each sensor node. In case the distance between 2 nodes lies inside a range R, the correspondence link is going to be viewed as individual hop or else it is viewed as multi hop. Figure 2 shows the network design considered for the proposed protocol.

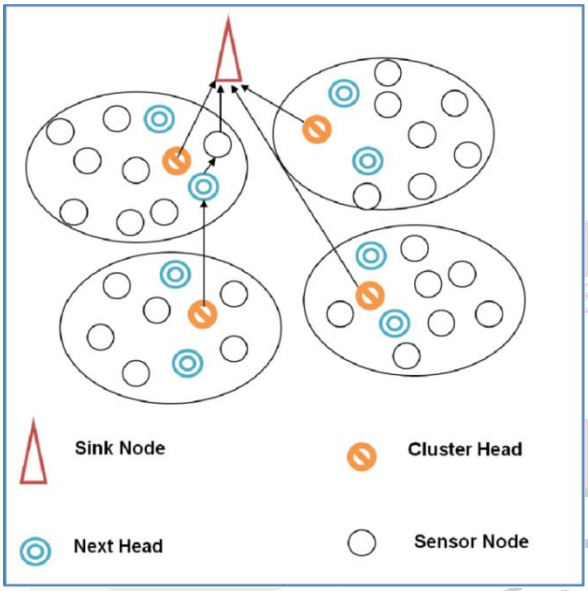

Figure 2: Network Model

The sink node is positioned within the network discipline. The network is actually partitioned into clusters as well as each cluster consists of a cluster head and couple of subsequent heads. The cluster members transmit information to the corresponding heads of its using TDMA as well as cluster head sends information to the sink node utilizing CSMA (either individual hop or even multi hop).

3.3 Energy Model

The transmitting and receiving energy for k bits over the distance d meters are Etx(k,d) and Erx(k)respectively are given in equations (1) and (2)

$$E_{tx}(k,d) = E_{elec} \times k + E_{amp} \times k \times d^{\gamma} \quad \textbf{(1)}$$

$$E_{rx}(k) = E_{elec} \times k \quad \textbf{(2)}$$

Where εfs is the energy of the amplifier to transmit one bit at one hop and εmp is actually the energy of the amplifier to transmit one bit at multi hop nodes. In case the distance between the receiver as well as the transmitter is actually d meters and the threshold worth of the distance is actually d_0, then the load loss exponent is actually provided as in equation (3) and (4):

$$\gamma = \begin{cases} 2, & d \leq d_0 \\ 4, & d > d_0 \end{cases} \quad (3)$$

$$d_0 = \sqrt{\frac{\varepsilon_{fs}}{\varepsilon_{mp}}} \quad (4)$$

From the equations (3) and (4), the equation (1) can be re-written as given in equation (6)

$$E_{tx}(k,d) = \begin{cases} E_{elec} \times k + \varepsilon_{fs} \times k \times d^2, & d \leq d_0 \\ E_{elec} \times k + \varepsilon_{mp} \times k \times d^4, & d > d_0 \end{cases} \quad (5)$$

The energy spent by the sensor node in the sleep mode is given by the equation (6):

$$E_{sleep}(t) = E_{low} \times t \quad (6)$$

wherever E_{low} is actually the energy usage of any node in sleep mode for one minute. The entire time invested in the sleep mode is actually t secs. The entire energy usage of a sensor node in the network is actually provided by the equation (7):

$$E_{total}(k,d) = E_{tx}(k,d) + E_{rx}(k) + E_{sleep}(t) \quad (7)$$

The energy consumed during transmitting as well as receiving k bit packets are actually defined to the air energy dissipation version as shown in the Figure 3.

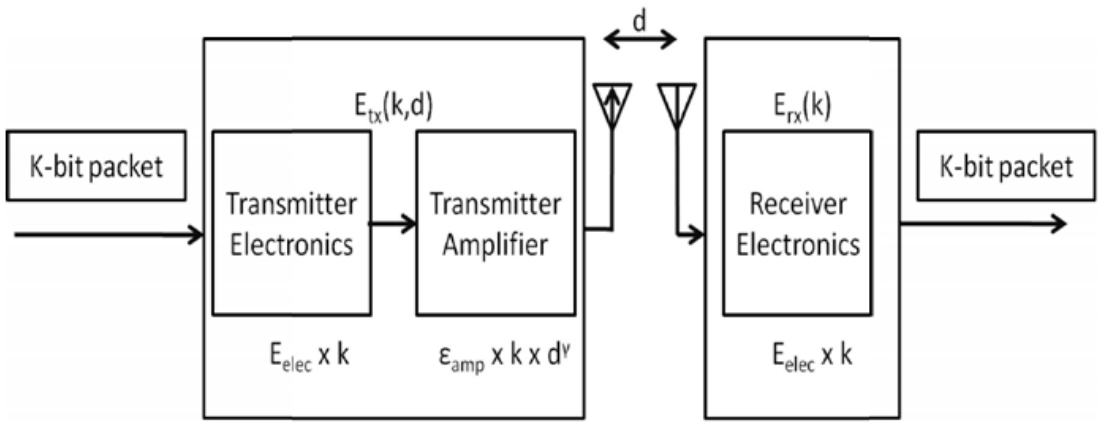

Figure 3: Radio Energy Dissipation Model

The transmitter dissipates energy to work the radio of its electronics amplifier and also the receiver dissipates energy to run its stereo as well as the power electronics.

Based on the distance between the transmitter as well as receiver, the free room and multipath models are actually used.

3.4 Modified-LEACH Algorithm

In this particular paper, Modified-LEACH algorithm, a cluster-based routing protocol for wireless sensor network is actually suggested. It's utilized to gather information from sent out sensor nodes and transmit information to the sink node. The Modified-LEACH algorithm is actually created to allow for periodic remote monitoring sensor networks.

The network task is actually organized into rounds. Each round has 3 phases specifically the setup phase, steady state phase and also the re-clustering phase. Figure 4 displays the functioning of Modified-LEACH.

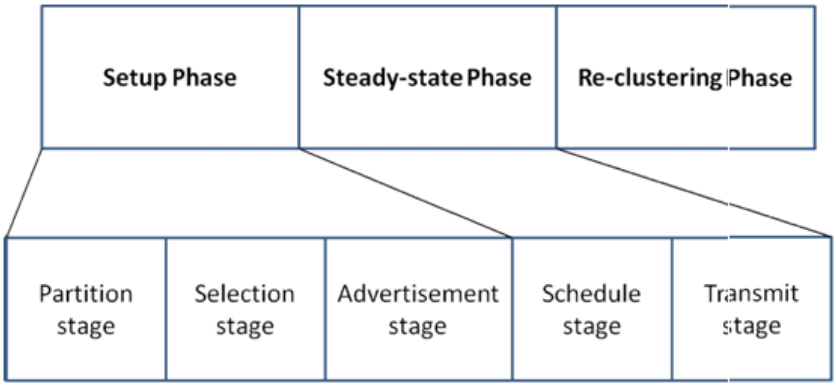

Figure 4: Operation of Modified-LEACH algorithm

The setup phase consists of 3 stages specifically the partition stage, selection stage as well as advertisement stage. This particular phase is actually in charge of choosing the cluster heads and clustering the network. The steady state phase comprises of 2 stages specifically the schedule stage as well as the transmit stage. With this phase, the cluster head gathers information from the users of its and forwards it to the sink node.

4. DATA ANALYSIS AND RESULT

In this particular section, the overall performance of the structure-less and structure-based routing algorithms are examined. The functionality of the structure-based algorithms Modified-LEACH and LEACH is actually examined as well as in contrast to the structure less Adhoc On Demand Distance Vector (AODV) routing protocol in phrases of energy use, packet delivery ratio and delay. The metrics are examined for the effect of network size as well as transmission fee. The intense set of simulation is conducted using NS2 simulator depending on the parameter illustrated in table 1.

Table 1: Simulation Parameters of Modified-LEACH Algorithm

Parameter	Description
Network area	500 x 500 m^2
Antenna model	Omni-directional
Propagation model	Two-ray ground
Number of sensor nodes	500
Initial energy	10 J
E_{elec}	50 nJ/bit
ε_{fs}	10 pJ/bit/m^2
ε_{mp}	0.0013 pJ/bit/m^4
d_0	87 meters
E_{tx}	0.6 J
E_{rx}	0.3 J

The following metrics have been used for the overall performance evaluation:

- Delay: It's the quantity of time taken by the nodes to transmit the information packets.
- Packet Delivery Ratio: It's the ratio of the selection of packets obtained to the number of packets delivered.
- Energy Consumption: It's the quantity of energy consumed by the nodes to transmit the information packets to the receiver.

4.1 Effect of Network size

The network size is actually varied by altering the selection of nodes as 100, 200, 300, 400 as well as 500. The packet size is actually 512 bytes as well as the transmission fee is actually 250 kbps for duration of simulation of 100s.

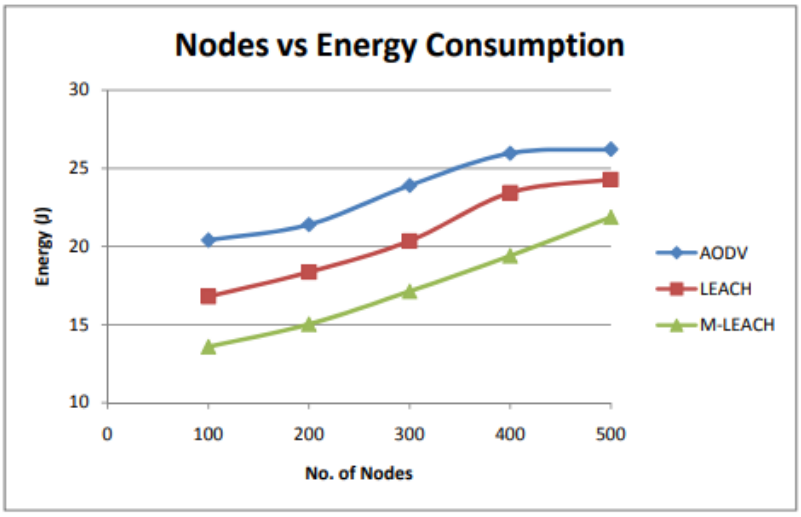

Figure 5 (a): Number of Nodes vs Energy Consumption

From the Figure 5(a), the energy usage of Modified-LEACH is actually twenty % less when compared to the LEACH protocol as well as thirty % under the AODV protocol. This is because of the election of future heads as well as cluster heads depending on the residual energy, which brings down the re- clustering of the network. Inside LEACH, re- clustering is completed after every round of different cluster heads and transmission are elected, which raises the energy usage in the network. Inside AODV, extra energy is invested in route establishment.

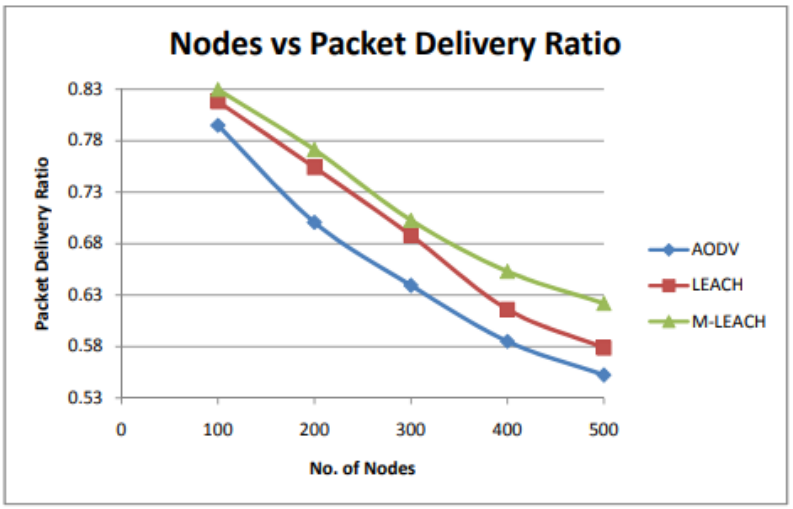

Figure 5 (b): Number of Nodes vs Packet Delivery Ratio

As the network size increases, the package delivery ratio of Modified-LEACH is improved when compared to LEACH and AODV protocols, as shown in Figure 5 (b). Inside Modified-LEACH, just high energy nodes become subsequent heads in addition to cluster heads, which boost the information forwarding ability. Inside LEACH, cluster heads are arbitrarily elected. Hence, energy nodes that are lower also can get cluster heads that leads to node failure.

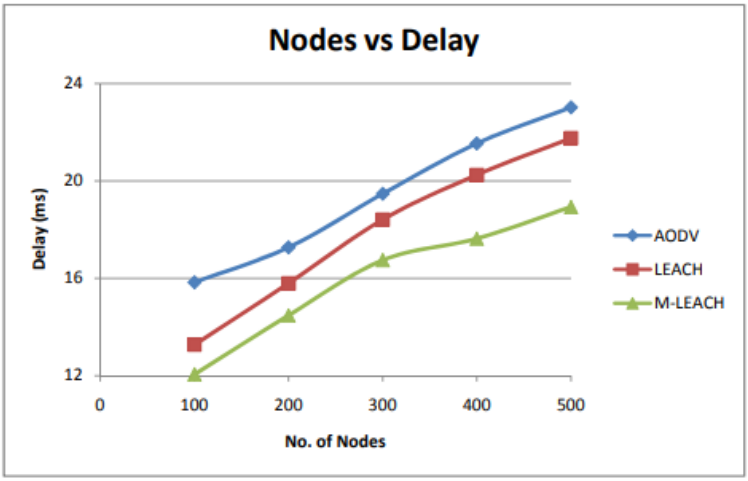

Figure 5 (c): Number of Nodes vs Delay

The delay in Modified LEACH is actually fifteen % less when compared to LEACH and twenty % less when compared AODV protocol, as shown in Figure 5 (c). This's because of the election of following heads as well as cluster heads based on residual energy. Since re-clustering is actually performed just if the residual energy of the elected heads goes beneath the threshold worth, the delay as a result of network reconstruction is actually lowered. Inside LEACH, the delay is actually elevated because of regular re-clustering.

4.2 Effect of Transmission Rate

The transmission fee is actually the amount at which the information is transmitted per device time. The transmission fee is actually varied as 100,200,300,400 as well as 500 kbps for the package dimensions of 512 bytes for a network size of 500 nodes as well as duration of simulation is actually hundred seconds.

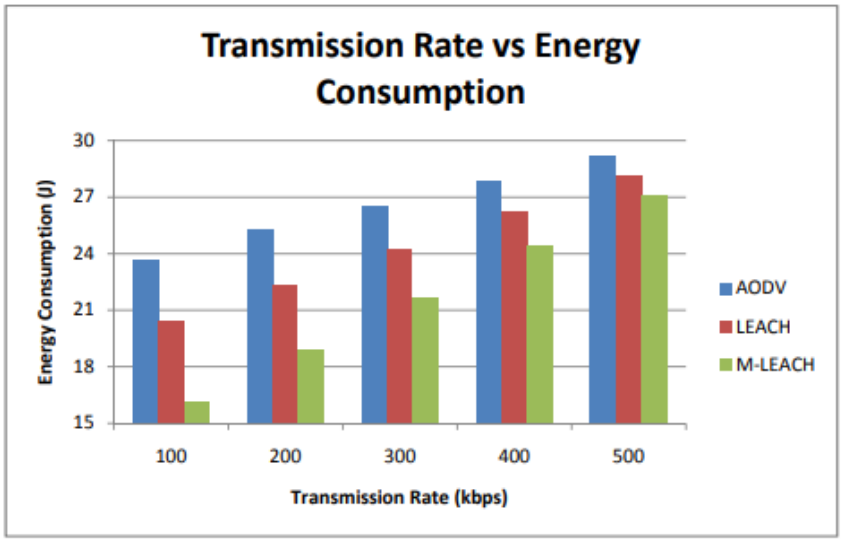

Figure 6 (a): Transmission Rate vs Energy Consumption

From Figure 6 (a), the energy usage of Modified-LEACH is actually twenty % less when compared to the LEACH and thirty % less when compared to the AODV protocols. Ever since the expansion in transmission fee increases the contention in the network, the packets are actually dropped because of to collision. This's stayed away from in Modified-LEACH by the collision avoidance mechanism, which decreases the complete energy usage. Inside AODV, the collision in the intermediate nodes raises the energy use due to increased re-transmissions.

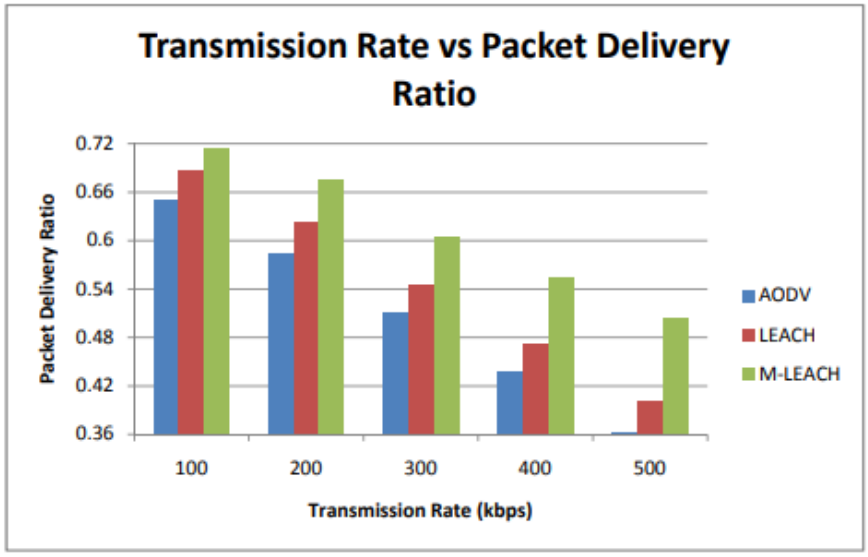

Figure 6 (b): Transmission Rate vs Packet Delivery Ratio

The packet delivery ratio of Modified-LEACH is actually twenty % much more than the LEACH and AODV protocols, as shown in Figure 6 (b). The increase in transmission rate leads to longer queuing congestion as well as delays in intermediate nodes. This can lead to a greater number of packet drops as well as raises the amount of re-transmissions. Since the collision avoidance mechanism is actually utilized in Modified-LEACH, the amount of re-transmission is actually cut back and packet shipping ratio is actually improved.

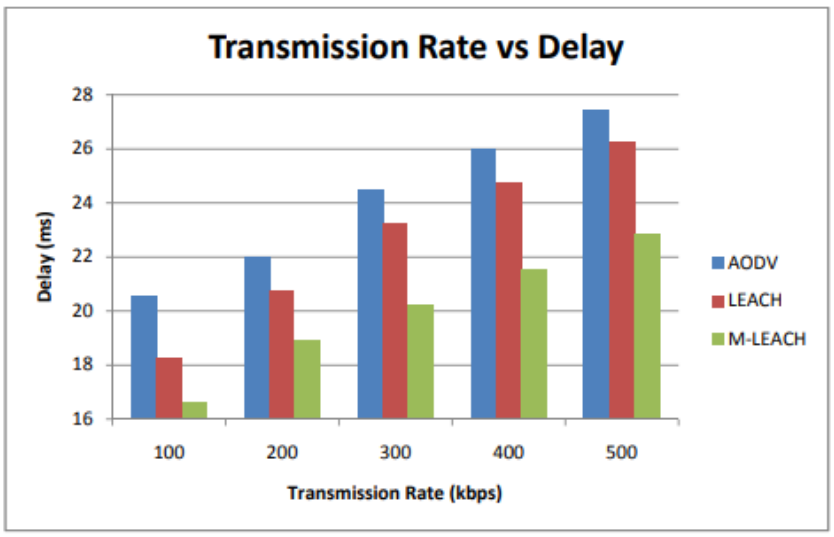

Figure 6 (c): Transmission Rate vs Delay

From Figure 6 (c), when compared to LEACH and AODV protocols; the delay is much less in Modified-LEACH. This's because of the diminished collision as well as re- transmissions in the network. The re-clustering is performed just if the residual energy of the elected heads goes beneath the threshold value; the cluster head utilizes the identical course to advanced information for an extended length. Hence the delay as a result of path establishment is decreased. Inside AODV, the delay is much more because of to re-transmissions as well as contention in intermediate nodes.

5. CONCLUSION

WSNs are utilized for different uses in the everyday living of ours. Since many sensors are often used on inaccessible and remote locations, particularly for

checking and surveillance programs, the deployment as well as maintenance must be scalable and easy. Because the sensor nodes are actually resource constrained, the efficient use of the materials particularly the energy resource is a lot decisive for retaining the life time of the WSNs. As energy is actually utilized much more for interaction objective, effective routing protocol style is actually a necessity for WSNs for prolonging the network lifetime.

An energy efficient hierarchical cluster-based algorithm is actually created that is a modification of the classic LEACH algorithm. A distinctive clustering strategy thinking about the residual energy of the nodes as well as the distance of theirs to the BS is actually carried out. This particular technique of clustering proved to be energy efficient compared to LEACH and may be utilized in WSN uses with homogenous sensor nodes. To further augment the energy efficiency, sink mobility, an energy efficient strategy is launched in to the enhanced LEACH algorithm

The proposed Modified-LEACH algorithm is actually a clustering-based energy successful routing strategy. The substantial characteristic of the algorithm is actually the election of subsequent heads together with the cluster heads. Because the sink node is actually to blame for this particular election, the nodes invest less energy in network construction. Extra to this, contrary to the LEACH protocol, the re-clustering is completed only after the residual energy of the elected heads goes beneath the threshold printer. Hence, the energy invested in regular network re- construction is lowered. Simulation results show this Modified-LEACH algorithm consumes twenty % less energy as opposed to the LEACH protocol as well as thirty % less energy in comparison with the AODV protocol. Within the proposed algorithm, although the regular re-clustering is actually stayed away from, the lifetime of the network isn't maximized. As the duration increases, far more nodes are likely to drop the energy of theirs largely in setup phase. To get over this, event based clustering algorithms might be employed.

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