Throughput Analysis of WM-LEACH, LEACH, MH- LEACH and V-LEACH Protocol: A Simulation Based Approach

IOP Conf. Series: Materials Science and Engineering **551** (2019) 012058 doi:10.1088/1757-899X/551/1/012058

Throughput Analysis of WM-LEACH, LEACH, MH- LEACH and V-LEACH Protocol: A Simulation Based Approach

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Abstract. This paper provides a passing description for some of routing protocols like LEACH, WM-LEACH, MH-LEACH and V-LEACH Protocol in Wireless Sensor Network (WSN) also a comparison study of these protocols based on one of performance matrices as throughput. Addition to this an attempt is done to calculate their throughput. The effect of these protocols are simulated through the MATLAB simulator. Finally, the throughput of the network increases with WM-LEACH with respect to send interval and number of bytes of data. In the WM-LEACH, the throughput is higher than in other protocols which are compared in this research. This is because the WM-LEACH protocol reduces the communication cost between the domains by allowing more data in less time.[-1].

1. Introduction

Wireless Sensor Networks (WSNs) have been utilized in various applications wirelessly. These applications include industrial applications such as mining, smart cities, smart emergency systems, and smart virtual power plants. WSNs may be categorized into infrastructure-less and infrastructure-based networks [1, 2]. The former one includes Base Station (BS) for sending data inside the network. Data networks that normally send data wirelessly are deployed either multi-hop or single-hop between the BS and all wireless nodes. Nevertheless, this category is unable to fulfill the demands of end users, even though the progress in this class has obtained a prodigious growth [3].

On the other hand, the latter class does not fix to a particular infrastructure and therefore known as ad hoc networks [4]. In this mode of transmission, the infrastructure is not involved as a BS, which connects other networks. Data transmission among contributing devices is achieved same as done in the infrastructure-less class, i.e., either through multi-hops or a single hop [5]. In this class of transmission, wireless devices share data with each other in a uniform communication range of an ad hoc network. Suppose, the required terminal is not in the range of the transmitting device, transmission is achieved indirectly, that is, in a multi-hop fashion [6, 7].

2. Related Works

For the improvement of LEACH, several extensions were proposed in the last decade [8, 9]. In this section, we elaborate the features of those extensions

2.1. Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH protocol is measured as the best procedure for WSN routing [10]. The idea of LEACH is being contemplated as an inventiveness for several routing procedures. The goal of this protocol is to select sensor nodes being the CHs in various cycles so as the outcome of extreme power excess (in communication with sinks) is obtained and then dispersed in the entire WSN.

This protocol includes the locations of CHs that are deemed of excessive power and random revolution as this switches among various nodes with the intention to stop a single node's battery to die. Primarily, rules are defined: a) sensor to reach sinks can utilize adequate energy for communications when it requires assistance from other nodes. b) Information that is inspected via a near device is measured the same and may be gathered. Sensors in this protocol administer itself with an indigenous block creating 1 device being a CH. The remaining sensors develop data transfer with the CH and the CH receives information from all nodes and exercise the task of data forwarding. Thus, the CH is believed powerful in comparison with other non-CH nodes.

3. Proposed Protocol

The proposed WM-LEACH protocol divides the communication process into several numbers of rounds. Each round comprised of a setup phase and data transmission phase. As previously mentioned, the setup phase is an overhead over actual data transmission. The primary focus of WM-LEACH is to reduce this overhead which causes improvement over the network lifetime. To accomplish this, WM-LEACH uses Alternative Cluster Head (ACH). This ACH hierarchy help to reduce the energy required to transmit necessary information for the setup phase to perform clustering operations. It also reduces the frequency of the setup phase using two schemes.

The first scheme is designed that relevant to multi-hop inter routing in which all CHs (include in clusters) are able to forward information to other CHs in other clusters. The second scheme copes with "multi-hop intra routing" in which sensors in the clusters are able to transmit data to all nodes for satisfying the idea of "multi-hop routing".

The designed two schemes focus on improving the lifetime of the network in line with minimizing usage of energy of the entire sensors in the system. Each of these phases is described in the following subsections comprehensively.

3.1. Initial Phase of WM-LEACH

This phase is not identical for all communication rounds. It differs based on whether the network has clusters or not. When the network has zero clusters, each alive node forwards a control message to the BS that consists of the ID, location and energy information.

The main shortcoming of LEACH is the random selection of CH that is applied to all sensor nodes without taking into account any factor. In reality, to increase the lifetime of network and energy efficiency, we need to change the threshold of selecting CH. In other words, we must consider four essential factors: the distance between the nodes and the bs, the residual energy, *RSSI* and nodes degrees within the transmission range, to calculate the threshold, which are calculated presented in (7):

$$\mathrm{cost(i)} = \frac{\alpha E_{res}(\mathrm{i}) + \beta N_{nbr}(\mathrm{i}) + \delta RSSI(\mathrm{i})}{\gamma d(\mathrm{i}, bs)} \tag{1}$$

$$E_{res}(\mathrm{i}) = \frac{E_{rem}(\mathrm{i})}{E_{init}(\mathrm{i})} \tag{2}$$

$$N_{nbr}(i) = \frac{N_{nb}(i)}{N_{alive}} \tag{3}$$

$$RSSI(\mathrm{i}) = \frac{1}{d^2} \tag{4}$$

$$\alpha + \beta + \delta = \gamma, \quad \frac{\alpha + \beta + \delta}{\gamma} = 1 \tag{5}$$

$$\alpha, \beta, \gamma, \delta \in [0,1] \tag{6}$$

where, E_{init} is the initial energy, $N_{nb}(i)$ is the number of neighbors of node *i*, N_{alive} is the number of alive nodes, $d(i, bs)$ is the distance between the node *i* and the *bs*. Then the threshold can be written as follows:

$$T(i) = \begin{cases} \cos t(i) & ; if \ \ i \in G \\ 0 & ; otherwise \end{cases} \tag{7}$$

4. Simulation and Result

The following sections discuss the analytical result of the proposed WM-LEACH scheme compared to the primary LEACH and V-LEACH schemes. For comprehensive evaluation, it starts simulation environment then the evaluation with the network throughput

4.1. Analytical and Numerical Analysis

The effect of WM-LEACH is simulated through the MATLAB simulator in 5 diverse setups: The first scenario consists of 50 SNs, the second scenario includes 100 SNs, the third scenario comprises 200 SNs, while the fourth and last scenarios comprise of 500 and 1,000 SNs, respectively. The selected amount of SNs changes and is sufficient for the performance evaluation and representing different network conditions.

The functioning of the WM-LEACH is evaluated in comparison with the primary LEACH, MH-LEACH and V-LEACH schemes. The functionality of these schemes is evaluated in all scenarios with 100 rounds. Chosen metric is network throughput, In presented figures, the x-axis demonstrates the amount of rounds in such a way that 10 and 100 are represent;ted by 1 and 10, respectively.

The basic LEACH, MH-LEACH, and the V-LEACH procedures are quite limited in throughput. Thus, this may be an extremely essential to analyze the throughput at the time of developing a novel idea for routing. Here, five figures, i.e., (a) to (c) demonstrate the received amount of bits (on average basis) on the BS with 50 to 1000 sensing devices in in 10 different rounds.

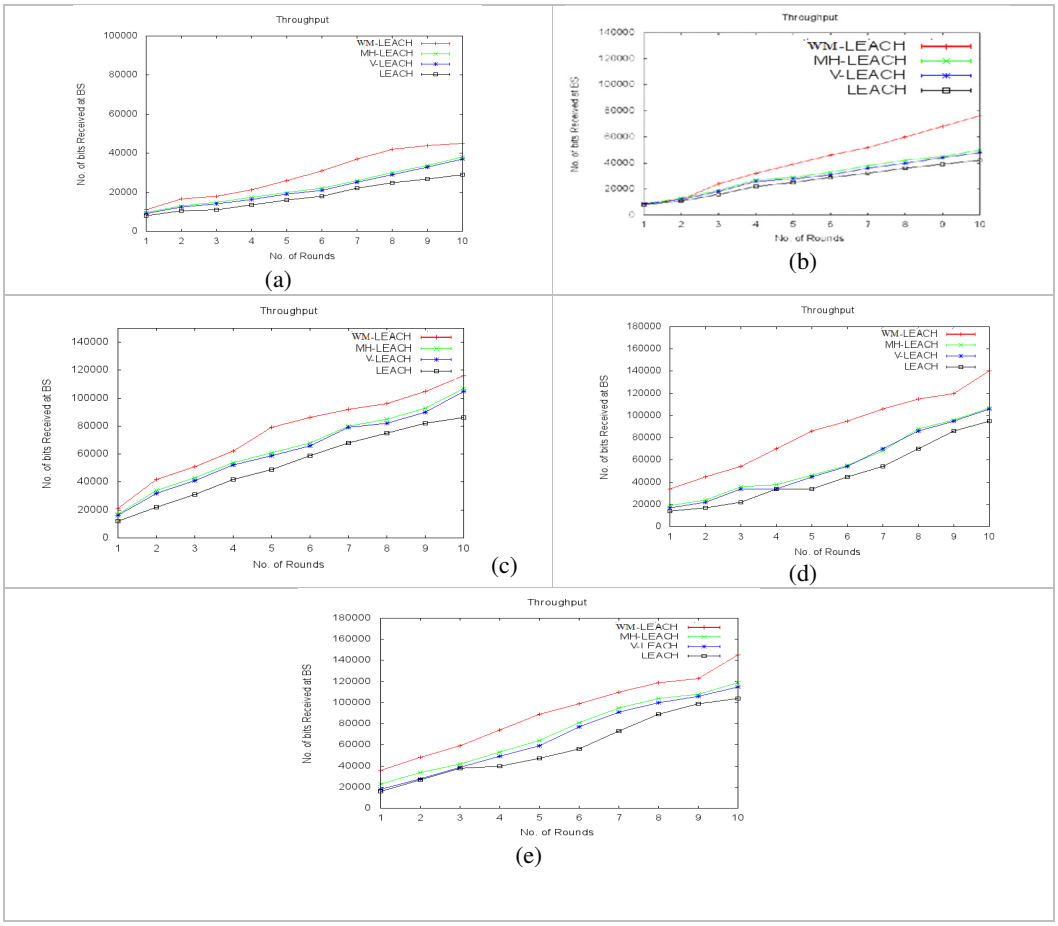

Figure 1. Obtained Throughput with (a) 50, (b) 100, (c) 200, (d) 500, and (e) 1000 Nodes Respectively

Our proposed protocol has the ability to improve the overall throughput of the network as this tries to reduce hops for a packet using splitting a network into different clusters. In addition, as compared to our proposed scheme, the remaining three protocols choose CHs on the basis of merely one parameter, i.e., either network lifetime, energy, or distance, thus, a multi-getaway to the network would aid to minimize the issue of blockage. Throughput, in terms of sent bits to the BS in all simulated schemes with only a 50 node network was such that the basic LEACH got 8000 initially and 29000 bits in the last round, as presented in figure 1. MH-LEACH = 9600 in the 1st round and 38000 bits in the final one. V-LEACH =9000 initially and 37000 finally. On the other hand, in our proposed protocol, in the first round the number of received bits was 11000 which then reached 45000 in the final round. Likewise, when the number of nodes was extended from 50 to 100 nodes, the proposed scheme received dominancy with 9000 bits initially which then finally reached 76000 bits, in comparison with LEACH, MH-LEACH, and V-LEACH that obtained 8000, 8600, and 8500 in the first round, and 4200 50000, 48000, in the final one, respectively.

Besides, the mentioned protocols were also examined when the network nodes reached 1000 from 200 nodes. That is, when the number of nodes was 200, LEACH obtained a throughput of 12000 bits initially which then reached 86000 in the final round. MH-LEACH received a maximum of 107000 bits in the final round as compared to 17,000 in the 1st one. V-LEACH obtained maximum 105000 bits in the 10th round in comparison with 16,000 initially obtained bits. Whereas, the WM-LEACH obtained the

following results: the number of received bits reached 116,000 in the final round which was 21,000 initially. When the number of network nodes was extended to 500, the recorded results were such that LEACH got 14,000 to 95000 in the 1st and 10th round, respectively. MH-LEACH attained 19,000 to 117,000 initially and finally, respectively. V-LEACH was recorded with 17,000 and 115,000 in the 1st and 10th rounds, respectively. Whereas in the WM-LEACH, the obtained results were as follows: 34,000 and 140,000 in the 1st and 10th rounds, respectively.
Lastly, when the network was extended to 1000 sensors, the recorded results were as follows; LEACH was observed with 16,000 and 104,000 in the 1st and 10th rounds, respectively. MH-LEACH was 23,000 and 119,000 in the mentioned two rounds. V-LEACH was recorded with 17,000 and 115,000, respectively, in the mentioned two rounds. The WM-LEACH achieved the following results: 36,000 bits in the initial round and 145,000 in the last round

5. Conclusions

This paper analyzed the functionality of our proposed scheme with regard to network throughput, the throughput of the network increases with proposed mechanisms with respect to send interval and number of bytes of data. In the proposed mechanism, the throughput is higher than in other mechanisms which are compared in this research. This is because the WM-LEACH mechanism reduces the communication cost (the overall amount of productively arrived information in one second. The determined stable throughput is the greatest amount of traffic in one second) between the domains by allowing more data in less time. In addition, WM-LEACH diverts the traffic in more than one path by choosing the path due to the multi-cluster approach. These are some of the reasons that help to increase the network throughput.

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