Study the Impact of Multiple Mobile Sinks on lifetime of Wireless Sensor Networks

Zubaria Andleeb[1], M.Rizwan Anjum[2], M. Usman Sardar[3]
UCET Islamia University Bahawalpur
Pakistan
zobariaandleeb@yahoo.com
engr.muhammadrizwan@gmail.com

ABSTRACT: *Extensive research is being done on Wireless sensor Networks (WSNs) in present decade. WSNs consist of large number of sensor nodes which perform sensing of certain phenomena and send the sensed data to the sinks. This operation consumes energy of sensor nodes which effects the lifetime of a network. To prolong the lifetime of WSNs various strategies and routing algorithms have been proposed. Use of mobile sinks has proved effective in this respect. In this paper we are analyzing the impact of multiple mobile sinks with proactive hierarchical clustering protocols LEACH and network reactive hierarchical protocol TEEN. This paper will give simulation based analysis of using multiple mobile sinks in network and their effect on lifetime of a network. Performance analysis will be done on basis of dead nodes, alive nodes, throughput and residual energy.*

Keywords: WSN, Mobile sink, dead node, alive node, throughput, residual energy

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1. Introduction

A wireless sensor network is an aggregation of deployed sensor nodes and interconnecting network, which sense, compute and react to the certain event in specific region or close to it. Mechanism of WSN can be demonstrated by four basic functioning: (1) sensing (done by sensing elements called sensor nodes distributed in a specific region.(2) interlinking (done by sometime wire based and usually wireless network.(3) data gathering (done at some main point).(4) computing(done by computing devices to interpret data at main point[1].WSNs are used in diverse applications including security, monitoring, healthcare, industrial and logistics etc. Sensor nodes are used in wide applications but usually deployed in a region where they are deprived of many resources including memory, power and energy etc [2].

Tiny sensor nodes need an energy proficient routing path to sink having fewer obstructions. Maintaining energy efficiency in routing paths to sink, the technique used to achieve less energy consumption is sink mobility [3].In case of static sink nodes which are near to the sink use to exhaust much earlier than those which are far away from sink due to higher data pass through these nodes. To address this issue sink mobility is introduced in which sink moves in specific path in WSN .Mobility of sinks also help in balancing load of data routing and depletion of energy[4].

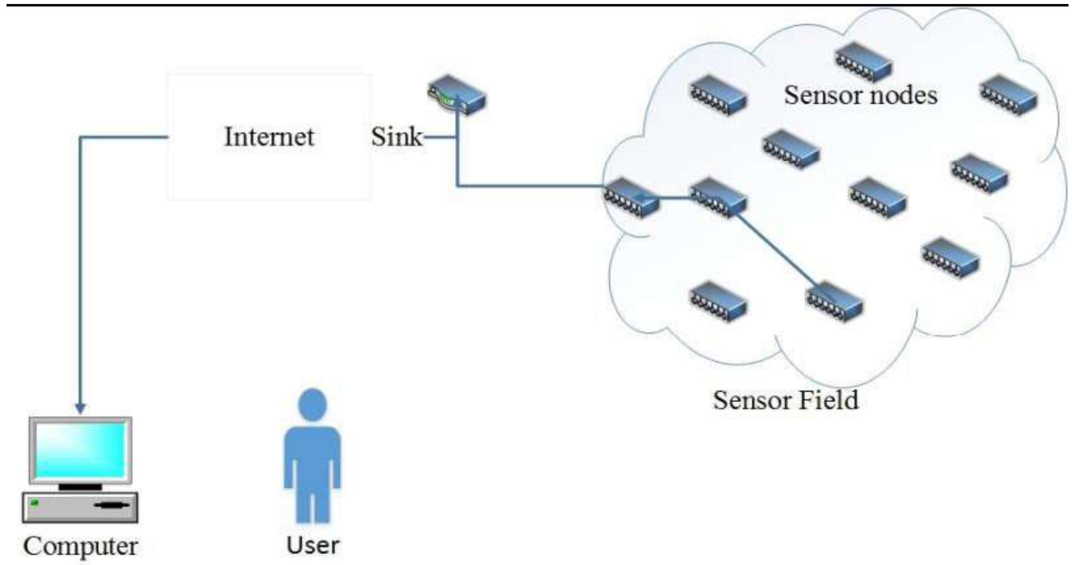

Figure 1. Overview of WSN with static sink

2. Related Work

2.1 WSNs consist of static sinks

In earlier years WSNs were consist of static sinks and static nodes. Although in practice multi-hop communication is desired to send data from node to sink. Consumption of energy depends upon the communication length. To lessen communication distance multiple static sinks were deployed in specific region. Authors deployed in [6 7] multiple static sinks and simulation proved the scheme for better energy efficiency. Though the location of multiple static sinks was a major problem, they must follow a pattern so that data between the nodes can be balanced. Authors in [8] give solution of this problem known as "facility location problem". Where for number of given facilities and consumers most favorable position of nodes is to be determined so that all nodes are equally burdened but in this case node which is near the sink deplete its energy faster.

2.2 WSNs consist of mobile sink

In order to overcome short comings of static sinks the use of mobile sink was proposed [3].Mobile sinks are programmed to follow different patterns in the specified field such as random, fixed or controlled mobility. In this paper mobile sinks will follow fixed mobility pattern. In fixed mobility sink follow a fixed path. Mobile sink follow a specified path so that it may complete its round through the network in minimum time. As a result energy dissipation is very low. To increase lifetime of a network optimum fixed mobility path is proposed by Luo et al [5].

Chatzgiannakis et al in [9] investigated coordinated and controlled motion of tiny parts of consumers in the network to attain optimal connection between other two nodes which are in motion. These nodes in the network act as passage to carry packets for other nodes in the network. This fundamental idea presents in by Shah et al in his investigatory work on data muls. These muls act as forwarding agents which were actually the mobile nodes. This concept saves energy in those networks which possesses single hop communication, instead more complex multihop communication from sensor to sink [10]. Further proceedings in this approach were done by Kim et al in [11] which propose diffused SEAD protocol. The idea explores the efficiency of mobile sinks for less energy consumption instead of using static sinks. To resolve the problem of nodes which die earlier and tend to shorten the lifetime of a network Authors in [18] demonstrated the idea of mobile sinks using linear programming and focused on nodes that how they deplete their energy at different locations in a network. The usage of specific movements of sinks were

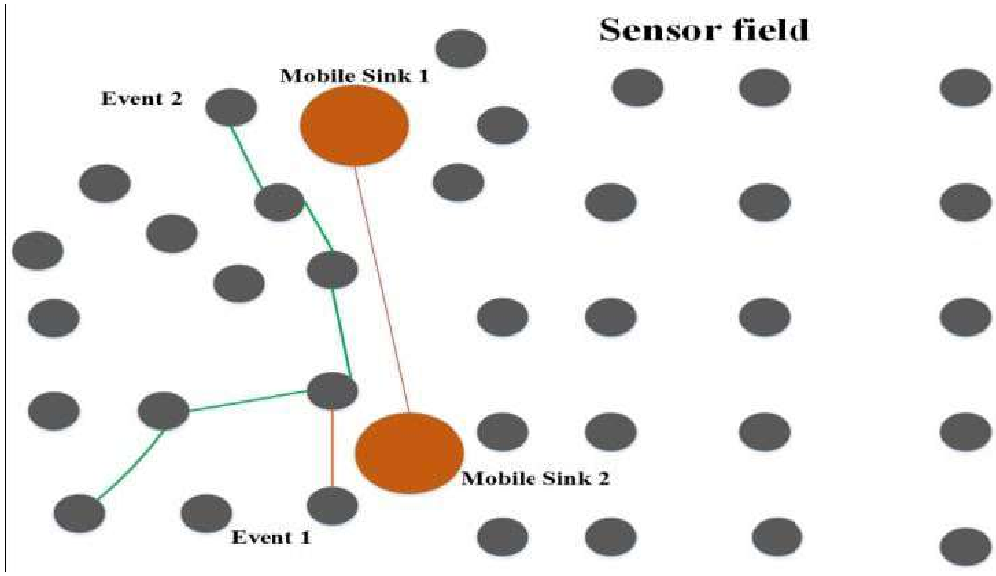

Figure 2. Overview of WSN with multiple mobile sinks

determined in [12].Where author proposes ILP (integer linear programming) model to track the location of multiple sinks in multihop communication. The model demonstrates the minimization of energy consumption per node and total energy consumption in a network at specific time. Aristotelis in [19] propose routing protocol to collect data from nodes when mobile sink pass by them, in this way transmission distance is minimized and nodes tend to expand less energy.

3. Motivation

Network lifetime is defined as the time until the last node in the network remains functional [13]. In order to increase the network lifetime and minimize energy consumption of nodes, research is focused on multiple mobile sinks [14-16]. In this thesis, our motive is comparative study of multiple mobile sinks in WSN. We shall incorporate multiple mobile sinks in traditional LEACH and TEEN protocols. LEACH is the very first protocol in the field of WSN for routing data from sensors deployed in the field for homogeneous networks. It uses static sink for data collection. It lacks mobile data collectors which is a hot topic in current research. On the other hand, TEEN is network reactive protocol.

4. Proposed Model

In this section we present our proposed protocols LEACH and TEEN where we have randomly selected a region of 100 sensor nodes. Parameters defined for LEACH and TEEN protocol are defined in a table below

Number of nodes	100
Transmitter Electronics	50nJ/bit
Receiver Electronics	50nJ/bit
Transmitter Amplifier	100pJ/bit/m2
Node Energy(LEACH)	0.5J
Node Energy(TEEN)	0.1J

Table 1. Specification of WSN

The energy consumption during transmitting and receiving process is calculated with the help of following equations [17].More energy is consumed during transmission than receiving process.

Transmitting:

$$ERx(k)=ETx\text{-}elec(k)+ETx\text{-}amp(k,d)$$

$$ETx(k,d)=Eelec.k+\text{-}amp.k.d^2 \qquad (1)$$

Receiving:

$$ERx(k)=ERx\text{-}elec(k)$$

$$ERx(k)=Eelec.k \qquad (2)$$

Same are the parameters defined for TEEN protocol but energy per node is defined 0.1 J. We used the fixed mobility pattern for sinks in a network. Fixed trajectories of single and multiple path is given below

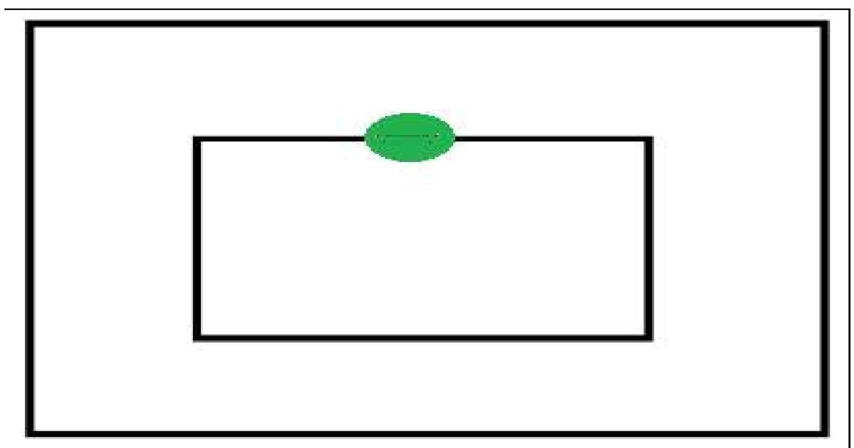

Figure 3. Fixed path of single sink

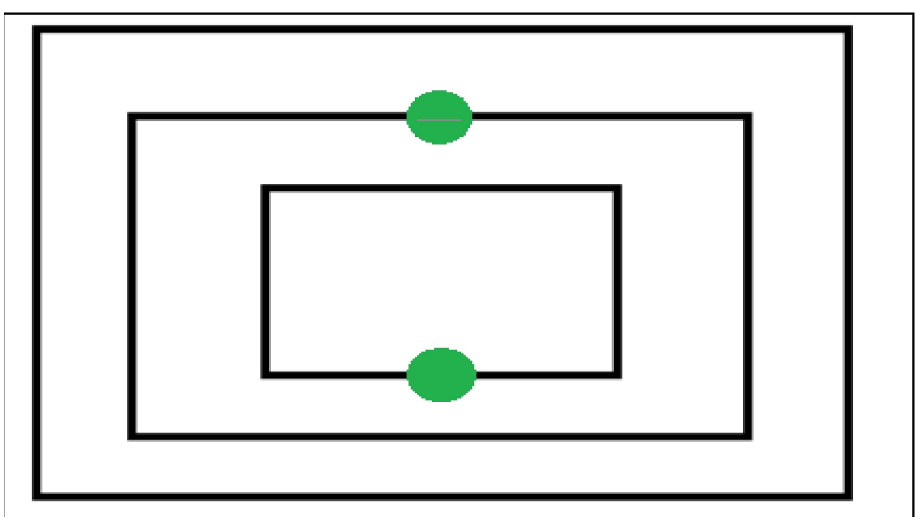

Figure 4. Fixed path of multiple sinks

5. Simulations And Results

Performance of both protocols LEACH and TEEN is compared with multiple mobile sinks .Where we have initially 100 alive sensor nodes in a region. Performance analysis is based on number alive nodes, number of dead nodes, throughput and residual energy after specific number of rounds of mobile sinks.

5.1 Number of Alive Nodes

This measure defines the total number of nodes and those nodes which have not expanded all of their energy. Both graphs show that of alive nodes decrease with time but using mobile sink increase the time span of nodes to remain alive. TEEN shows better results than LEACH as evident from graph.

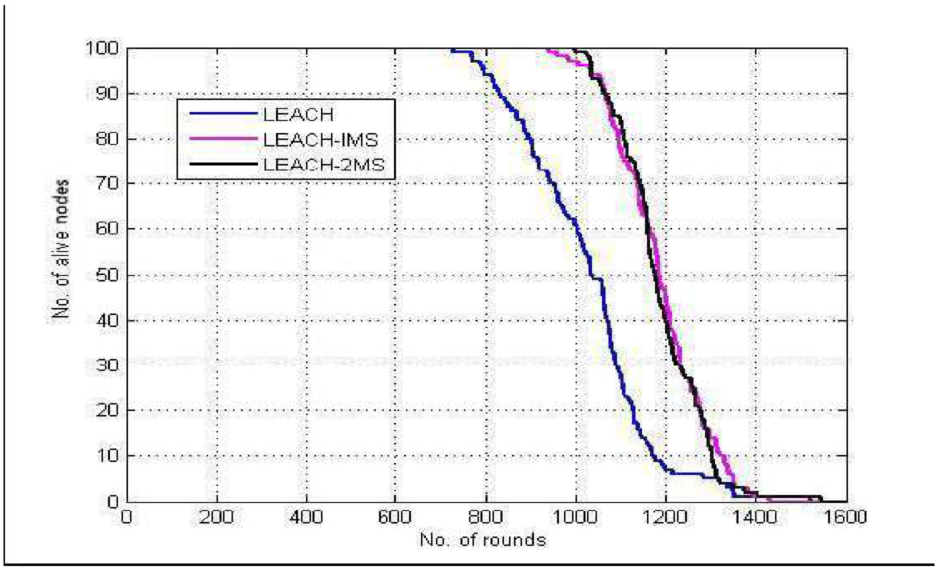

Figure 5. Number of alive nodes decrease with time

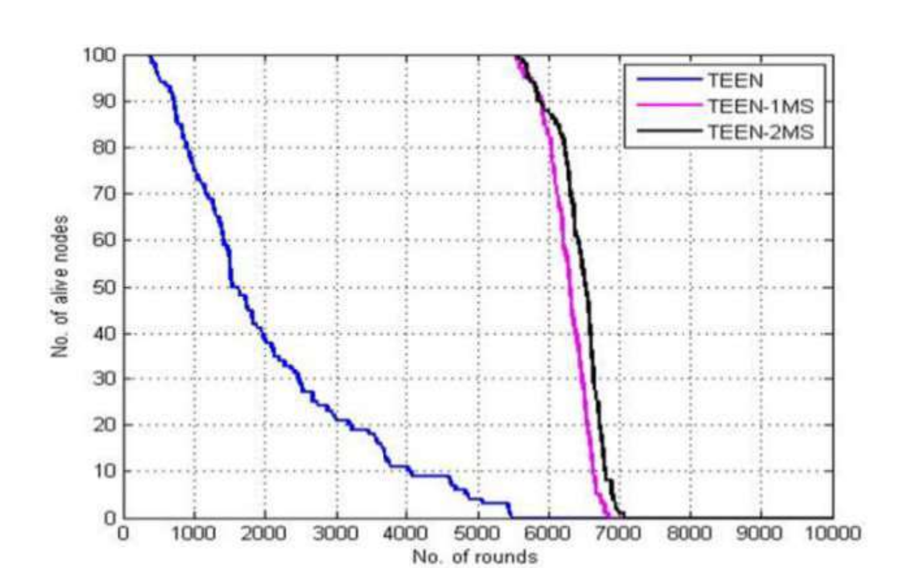

Figure 6. Number of alive nodes decreases with time

5.2 Number of Dead Nodes

Reflects the total number nodes and the nodes which have consumed all of their energy. Both LEACH and TEEN give improved results when mobile sinks are placed in a network. multiple mobile sinks give better results than using single mobile sink.

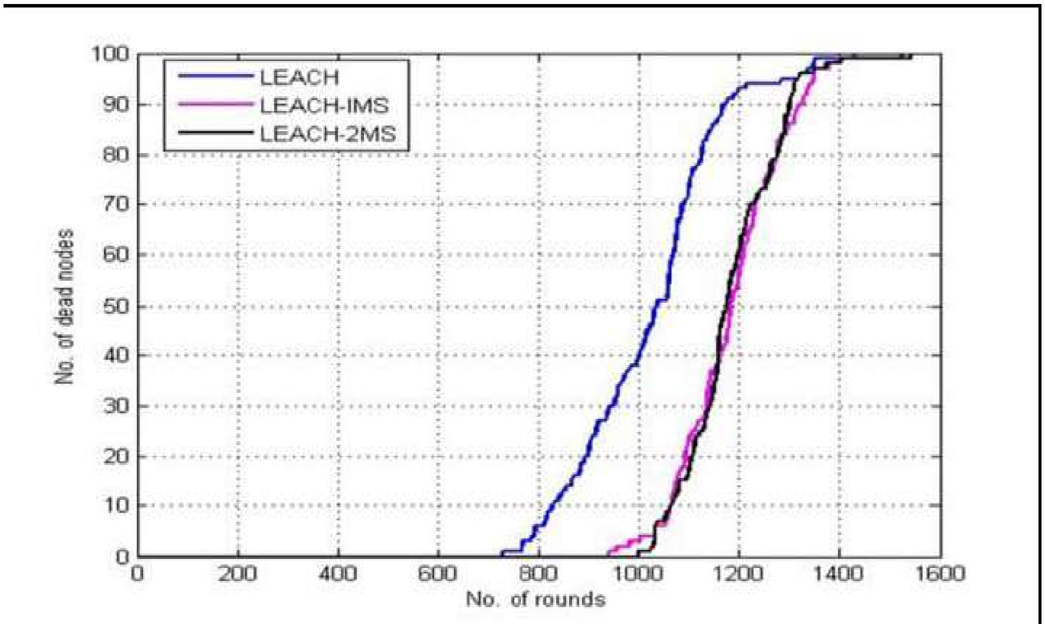

Figure 7. Number of dead nodes increase with time

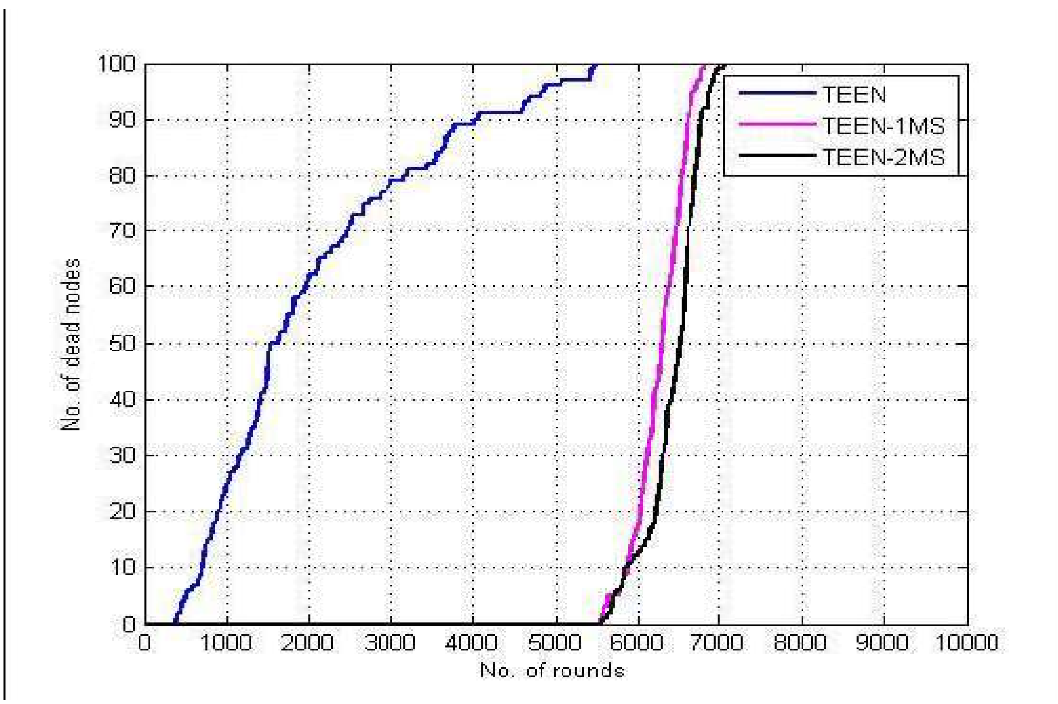

Figure 8. Number of dead nodes increase with time

5.3 Throughput

Throughput describes all the data sent in a network, data sent between CHs, BS and nodes. It is evident from graphs that throughput increases with time but there is remarkable difference seen in fig 11 when TEEN is used with multiple mobile sinks.

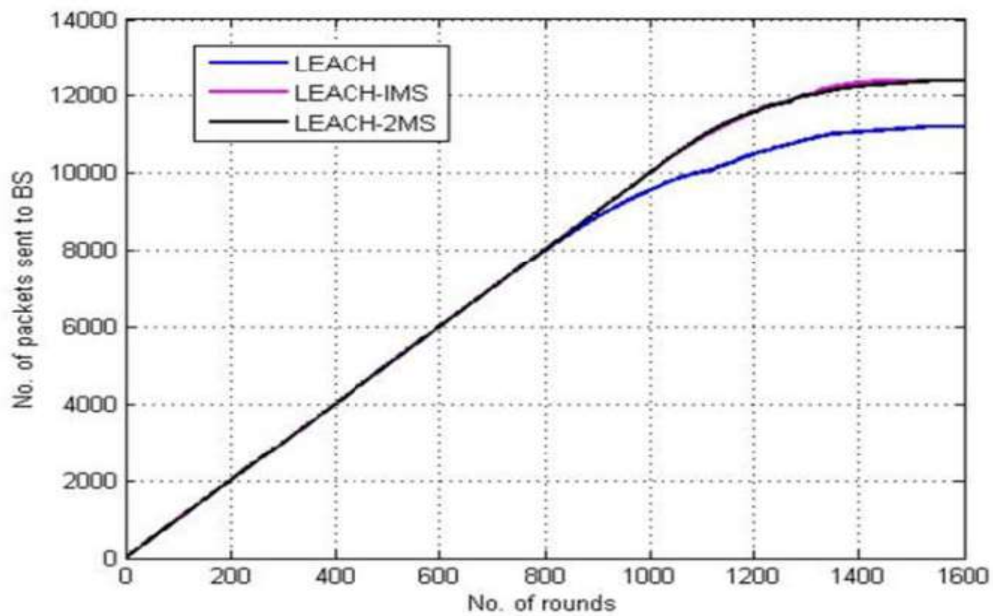

Figure 9. Throughput increases with time

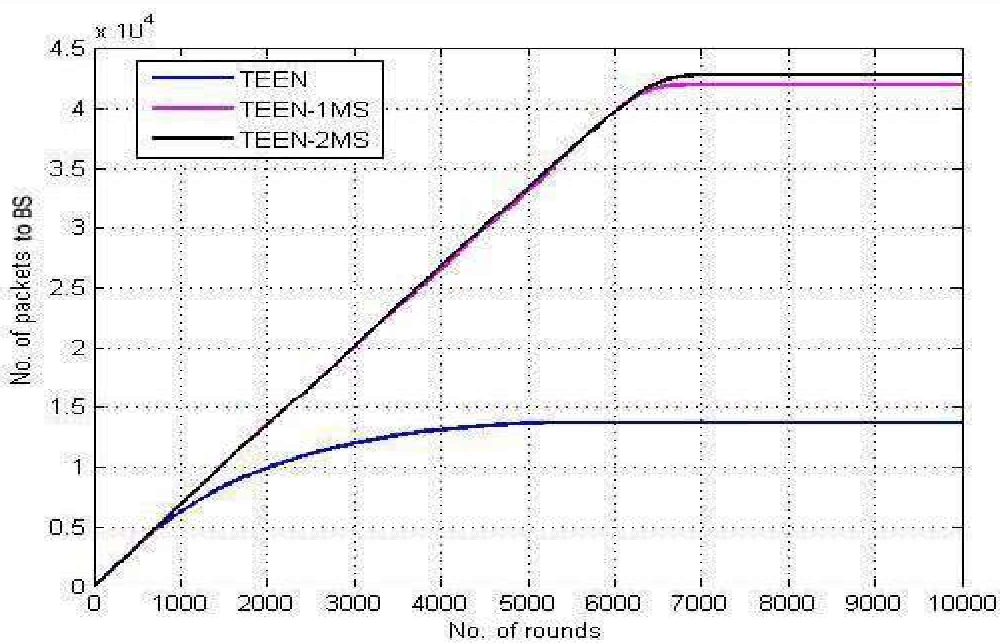

Figure 10. Throughput increases with time

5.4 Residual Energy

Reflects after completion of some rounds the energy remained in sensors. Residual energy decreases with time .But use of multiple mobile sinks tend the sensor nodes to deplete their energy slower thus increasing lifetime of a network.

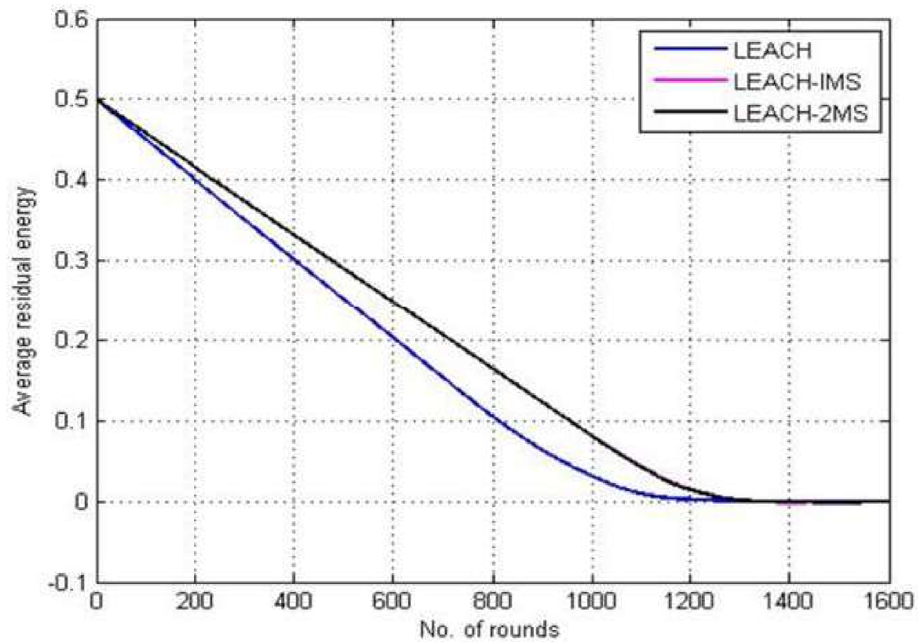

Figure 11. Residual energy decreases with time

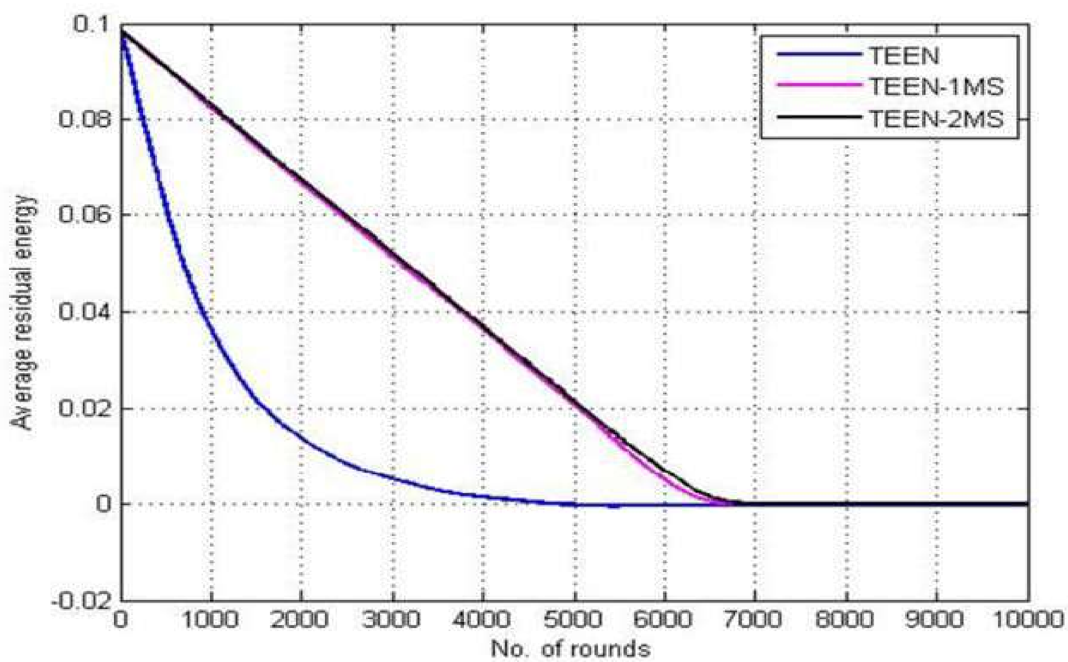

Figure 12. Residual energy decreases with time

6. Conclusion

As mobile sink move in the network, it collects data from nodes deployed in the field. Contrast to the static sink, mobile sink is located at lower distance tend network to consume less energy. Finally it increases the network lifetime. As it is the evident from simulations. But network reactive TEEN is seemed to be more effective gives sharp graphical representations when used without mobile sink and when used with mobile sinks. TEEN is seemed to be more effective in order to increase lifetime of a sensor network.

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