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A Novel Approach Using EVELCT Based Scheme for Prolonged Network Communication

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ABSTRACT: Wireless Sensor Networks (WSNs) play a crucial role in today's real world applications. The efficiency of WSNs purely depends on the data gathering schemes. Various data collection schemes such as multipath, chain, tree, cluster and hybrid topologies are available in literature for collecting data in WSNs. However, the existing data collection schemes fail to provide a guaranteed consistent network in terms of mobility, traffic, and end-to-end connection. In this paper, an Enhanced Velocity Energy-efficient and Link-aware Cluster-Tree (EVELCT) scheme for data collection in WSNs is projected which would effectively lessen the problems of coverage distance, mobility, delay, traffic, tree intensity, and end-to-end connection. The proposed EVELCT constructs the Data Collection Tree (DCT) based on the cluster head location. The data collection node (DCN) in the DCT does not participate in sensing the collection of data, it simply collects the data packet from the cluster head and delivers it to the sink. The designed EVELCT scheme minimizes the energy exploitation, avoids frequent cluster formation, reduces the end-to-end delay and traffic in cluster head in WSNs by effective usage of the DCT.

KEYWORDS: Velocity energy efficient and link-aware cluster tree; Data Collection Node; Data Collection Tree; Network lifetime; wireless sensor networks

I. INTRODUCTION

WSNs have recently come into prominence because they hold nano technology and MEMS (Micro Electro-Mechanical Systems) to design networks with tiny distributed sensors and actuators. Likewise, emerging technology in communication hardware, low power VLSI and embedded computing are combined together to make this technology appear as a reality, the union of computing and communications (i.e., electronic technology and wireless communication) makes potential to revolutionize in many segments of our life. It includes economics, environmental monitoring, mining, meteorology, seismic monitoring, acoustic detection, health care applications, process monitoring, infrastructure protection, context aware computing, undersea navigation, smart spaces, inventory tracking and tactical military surveillance. The node which is closer to the sink has to transfer more data. These nodes consume more energy than the node which is in remote areas. To overcome all these problem multi sink have advantage of dispersion, stability, battery power consumption and robustness.

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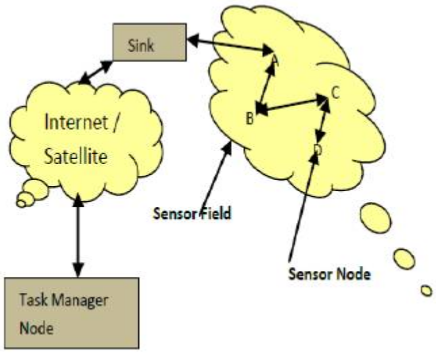

Figure 1: Architecture of Wireless Sensor Network

II.PROBLEM DEFINITION

Communication is the main factor of energy dissipation in sensor nodes as studied in. The dissipation depends on the distance between communicating elements as source and destination. Electronics such as sensing units and probable Global Positioning System on sensor nodes have also importance on energy utilization. Having inadequate sources require energy-aware routing protocols running on the sensor nodes. The protocols running on these networks should be simple-structured, fast executable and need low power for successful applications. The basic method to transfer information from sensor nodes to the base station is called flooding in which all sensor nodes are communicating by broadcasting. This method consumes too much energy and bandwidth while disseminating data to all over the network as well as the base station. In some scheme there is no predefined topology to transfer the data from the sensor nodes to sink. Here, all the sensor nodes directly communicate with the sink or simply forwards the data packets to the one-hop neighbor nodes and finally reach to the sink. The existing methods have restrictions such as delay, node failure, data redundancy and large amount of energy utilization, since, it is using flooding, gossiping, direct communication, etc., to communicate between the nodes.

III. RELATED WORK

The topology of WSNs resolves the overall efficiency of the network. The classification of network topology based on the data
gathering and dissemination applications, various types of logical topologies are classified as
(i) Flat/Unstructured Topology (ii) Chain Based Topology (iii) Cluster Based Topology (iv) Tree Based Topology
(v) Cluster Tree Topology, etc.

A. Flat/Unstructured Topology (FT)

FT/UT is a very easy method to gather the data from the remote location to sink [6], since it uses flooding, direct communication, gossiping, etc. Here, each sensor node plays an equal role and forwards the data packet to the one-hop distance neighbor nodes or selected neighbor nodes. Since, FT does not have any predefined topology, and it is used in the case of absence of the defined topology which does not having the energy conservation mechanisms, which lead to the implosion and overlapping problems [3]. E.g., SPIN, Directed Diffusion, EAR, Rumor routing, GBR, CADR, COUGAR and ACQUIRE.

Kulik et al. [8] developed SPIN (Sensor Protocols for Information via Negotiation), to resolve the issues of flooding, overlapping of sensing areas and resource blindness. The algorithm starts the transmission with an advertisement message which is used to advertise a particular meta-data. The advertisement message id followed by a request message which requests the specific data. The data message carries the actual data. The advantages of the SPIN protocol includes topological changes are localized (i.e., each node wishes to know only its one-hop neighbor nodes) and it provides better performance than flooding. However, the data advertisement mechanism cannot assure the delivery of data. Therefore, it is not suitable for intrusion detection applications which require reliable data packets delivery over periodic intervals.

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B. Chain Topology (CT)

In CT, a sensor node is selected in the chain to act as a leader, and then the remaining sensor nodes can communicate with each other along the chain path. Excessive delay from distant nodes on the chain is the main demerit of this topology (i.e., data collection on the longer chain obtains larger time). Based on the applications, numerous sensor nodes have been elected to act as a chain leader to avoid the excessive delay, and cover the chain to the entire WSN.

C. Cluster Based Topology (CBT)

Ye et al. and Liu discussed CBT has been widely used in WSNs for data gathering, data dissemination, target tracking, etc. Clustering is a proficient method, widely used in dense WSNs, scalability to hundreds or thousands of nodes. Scalability in this context implies the need for proficient resource management, data fusion/aggregation, load balancing, robustness, etc.

D. Tree Based Topology (TBT)

In TBT, all the deployed sensor nodes can construct a logical tree. Generally, TBT works with DFS (Depth First Search) or BFS (Breadth First Search) method [6]. Here, the entire data packet passes from leaf node to the parent nodes. Likewise, data flow from all sensor nodes to the sink is carried out. Constructing a logical tree avoids packet flooding. It uses unicast instead of broadcast, since the flooding is not necessary for data communication. Therefore, tree topology consumes less power than flat topology. When compared to a few basic clustering protocols, tree topology proves to be much more effective on energy utilization.

E. Cluster Tree Topology (CTT)

CTT holds clusters and tree topology, then the topology design starts with a special node called DD (DesignatedDevice). It acts as a cluster head with greater transmission power and receiver sensitivity. The beacon signal contains NetID (IDentity of the Network), CID (Cluster IDentification) and NID (Node IDentification) nodes which are added to the DD. Then, the CONNECTION REQUEST and CONNECTION RESPONSE are used to create a cluster tree based on the beacon reception of the sensor node from a neighbor sensor node. Here, the CTT creation with node id is a tedious process. Because, the DD should be initiated to construct a cluster tree (e.g., ZigBee and 6LoWPAN). The major goal of cluster tree is to reduce the energy exploitation, end-to-end delay and improve the capacity of WSNs.

IV. PROBLEM WITH SINGLE SINK

A) Routing with Single Sink

If routing is done by using single sink then sensor nodes have to wait to send data to that sink. If multi sink with fixed trajectory the choice of mobility path influences energy efficiency is possible. On the other hand in single sink application sensor nodes spend a large fraction of their total lifetime in waiting to send data to sink.

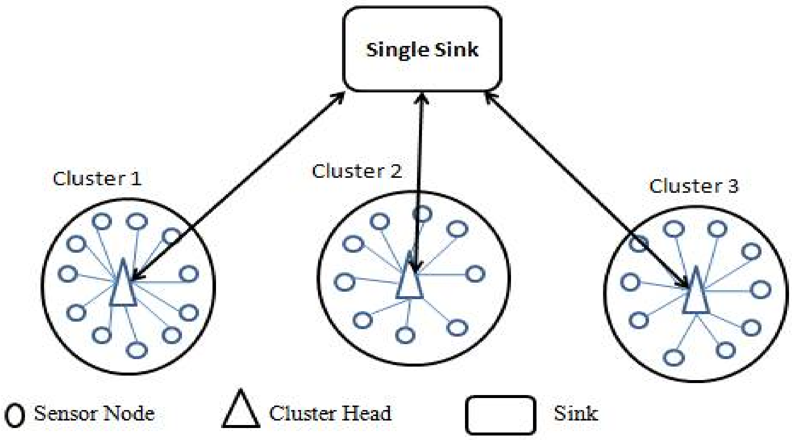

Figure 2. Single sink wireless sensor network

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B) Hot Spot problem in Single sink

In single sink the node which is nearer to sink is busy in sending it's own data and also it's preceding sensor nodes data, due to this energy of these nodes decreases rapidly. Hence it creates holes in the network. This problem is called as "Hot Spot Problem".

C) Why Multi-Sink?

Multi sink routing is needed for the distant sensor nodes from sink to the energy. The nodes nearer to the sink can be burdened with relaying a large amount of traffic from other nodes. This phenomenon is called as energy hole problem or crowded center effect problem.

V. THE EVELCT DESIGN

The EVELCT scheme consists of set-up phase and a steady state phase. In the set-up phase, cluster formation and data collection tree construction is initiated to identify the optimal path between cluster member and sink. Then, the steady-state phase is initiated to transfer the data from the cluster members to the sink.

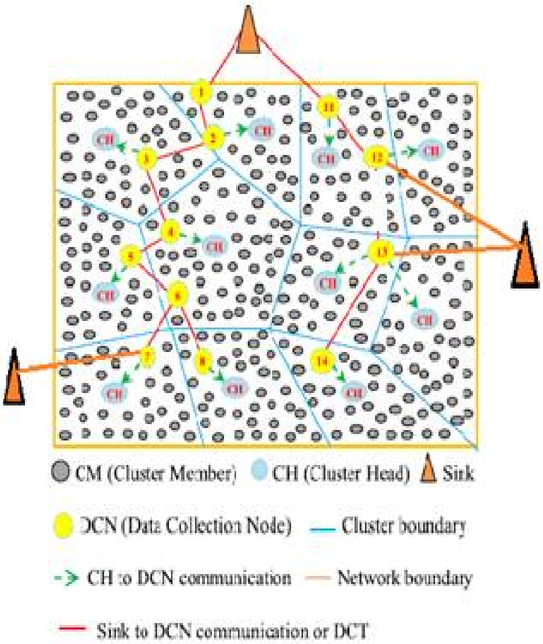

Figure 4: EVELCT Structure

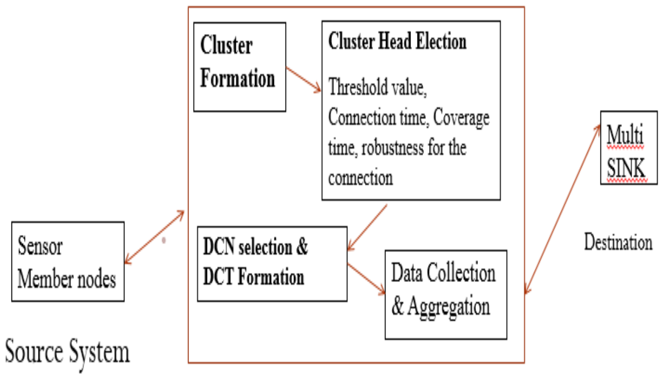

Figure 5: EVELCT System Architecture

A. ***Set-up Phase***

Set-up phase carry out with the intra cluster communication and DCT communication operations. In an intra cluster communication all the sensor node elects the cluster head with threshold value, and forms a cluster with better connection time, RSS, coverage time and robustness for connection. After the intra cluster communication, DCT communication is initiated to collect the data from its cluster head and then forwards the aggregated data packet to the sink.

1) Intra Cluster Communication: Considering ambiguous large-scale WSNs, sensor nodes have been densely deployed over the region. During the set-up phase, the beacon signal is used to identify the sensor nodes location and position. Once the nearby nodes are identified, cluster head election algorithm is used to elect the cluster head. Now, the cluster head selection is based on the threshold value *Un ϑ_*, connection time *_D_ϑ_ (t, t + s)*, coverage time *_I_ϑ_ (t, t + s)*and robustness for connection *Gn ϑ_*. After the cluster head election, the next phase DCT formation is initiated. Those nodes having maximum number of cluster members, residual energy, RSS and connection time can be elected as cluster head:

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$$U_{V\varpi}^{n}=F_c+\left(\frac{N_{\varpi}^{C}}{N_N^{m}-N_{\varpi}^{C}}\times\frac{E_N^{m}-E_{\varpi}^{C}}{E_N^{m}}\times\frac{V_N^{m}-V_{\varpi}^{C}}{V_N^{m}+V_{\varpi}^{C}}\times\frac{R_N^{m}-R_{\varpi}^{C}}{R_{\varpi N}^{m}+R_{\varpi}^{C}}\right) \qquad \text{eq. 1}$$

2) Data collection tree formation: DCT is a hierarchical tree structure, which uses DCN to collect the data from the cluster head and deliver it to sink, and that covers to the whole WSNs. Here, the sink selects the DCN based on the threshold value, connection time, RSS, communication range and heftiness for connection, which reduces the surplus energy usage and traffic of the whole network.

B) Steady-State Phase: Once the set-up phase completed, steady-state phase is initiated. In steady-state phase, all the cluster members send the collected data the collected data to the cluster head in allocated time slots. Then, the cluster head starts to collect and aggregate the data from its cluster members. Meanwhile, the DCT communication is initiated, which uses Direct Sequence Spread Spectrum (DSSS) to transfer the data from the cluster head to DCN and then the sink. Here, the DCN collects and aggregates the data from the corresponding cluster head or DCN.

VI. PROPOSED ALGORITHM

The proposed work concentrates on multiple sink single hop routing. The nodes and the sinks are randomly deployed. At the first instance the nodes are connected to a sink depending upon their distance and the transmission energy. A node gets connected to a sink/s if its distance from the sink/s is less than the transmitting range. In this way all the nodes are connected to one or many sinks.

System Model and Assumptions

(1) Sinks are randomly deployed and then they are fixed. Since random distribution is used, the complexity in determining the position of the sink is removed.
(2) The nodes after random deployment are formed as clusters.
(3) The density of nodes deployed is high such that the data from a node reaches a sink in single hop.
(4) The sinks have more power than the sensing nodes. The sinks have additional computational capacity as well.

Pseudocode

(1) The sensor nodes and the sinks are randomly deployed and after the deployment the nodes and sinks are stationary. Combination of sink and sensor nodes will make the network heterogeneous.
(2) N is the set of p nodes deployed in the area to be sensed in the given network: $N = \{n1, n2, n3, \ldots, np\}$.
(3) S is the set of q sinks deployed in the area to be sensed in the given network: $S = \{S1, S2, S3, \ldots, Sq\}$.
(4) Calculate the Euclidean distance from each sink to every node.
(5) The threshold energy of the sink is $E0$.
(6) The transmission range of a node is Tx.
7) The neighboring nodes of every sink are calculated based on the transmitting range.
(9) The energy consumed by ith sink Ei is calculated by $E_i = k\sum_{j=1}^{n} Dij^2$
(10) Calculate the Emax = maximum(Ei), where i = 1 to q,and find the maximum energy consumed by any sink Si.
(11) If (E0> Emax),{
no need to optimize the network
iteration = 0;
set the E
0 below the Emax
repeat step (10)
}
(12) Now the network is optimized and the routing is started by the nodes. The lifetime of the network is calculated by counting the number of rounds done by the network before the first node dies out.

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VII. RESULTS AND DISCUSSION

This simulation result specifies the details of the snapshots of the project. The snapshot defines how the proposed work has been implemented. The snapshots of the project discussed as follows.

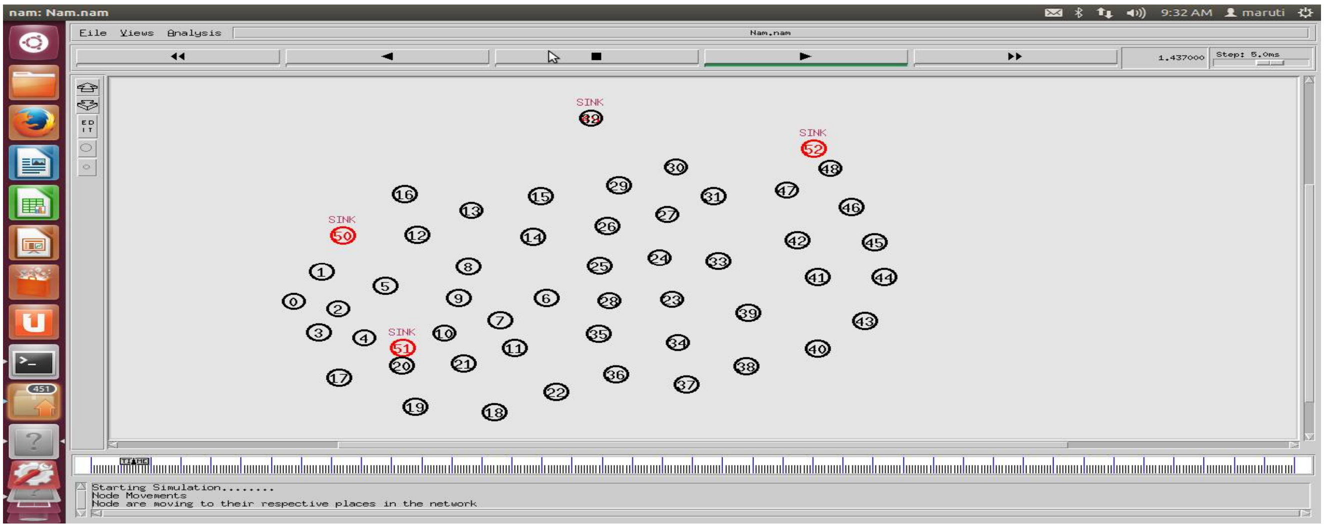

Figure 6: Random Deployment of nodes with Multi sinks

Fig 6 shows the creation of nodes with multiple sinks; here first we are sending the random node deployments i.e. sending the neighbour node request to all the other nodes in the network

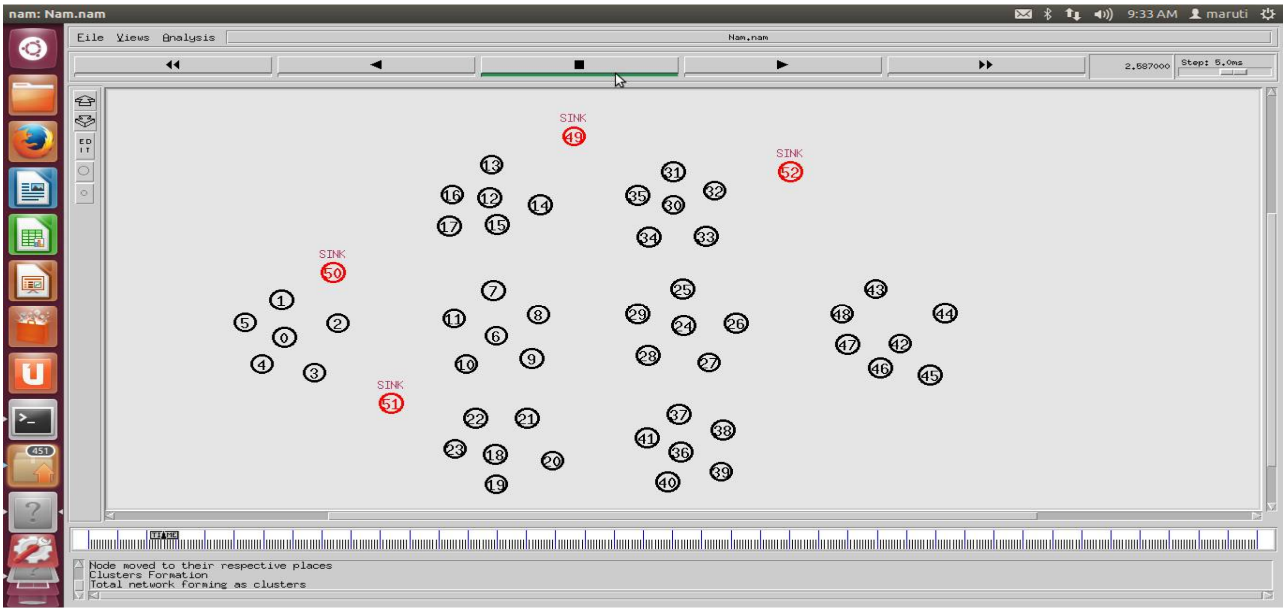

Figure 7: Cluster Formation

The above figure shows the formation of clusters in the network. All the nodes move to the corresponding locations to to form the clusters

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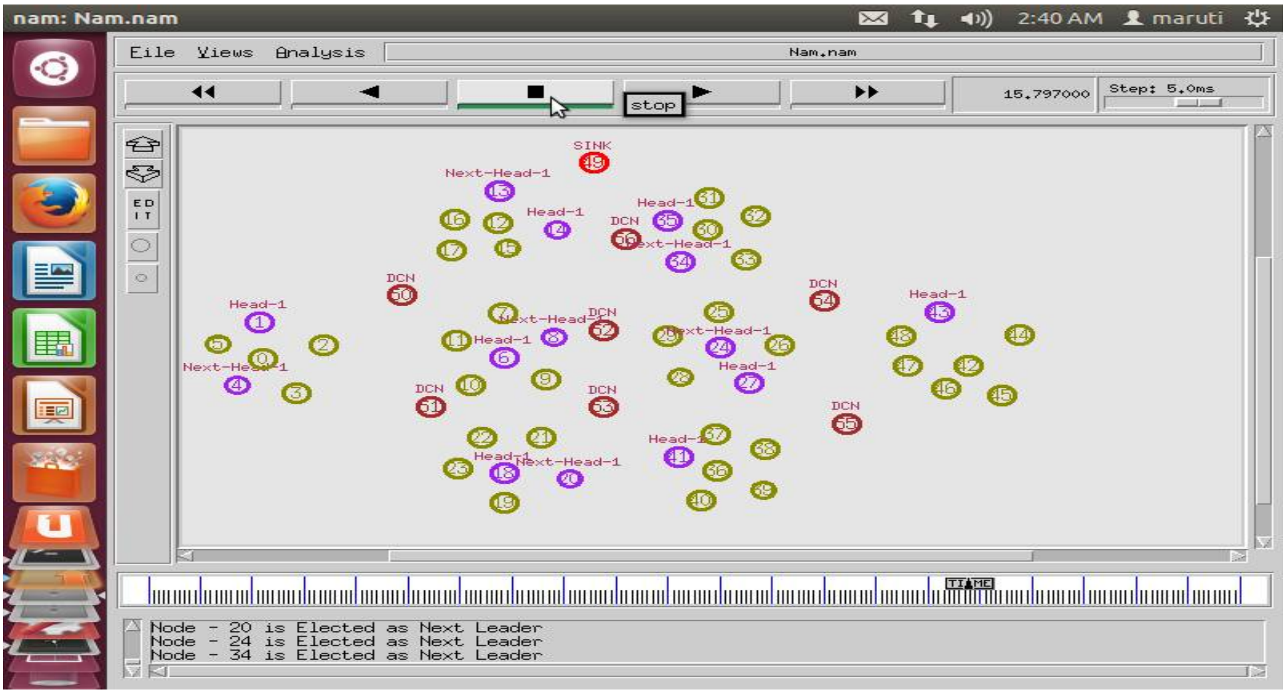

Figure 8: DCN Selection and Cluster Head Elected Nodes

Fig 8 shows that the Cluster Heads are elected using threshold value, connection time, coverage time and robustness for the connection and then the nearby nodes to the cluster heads are elected as Data Collection Nodes.

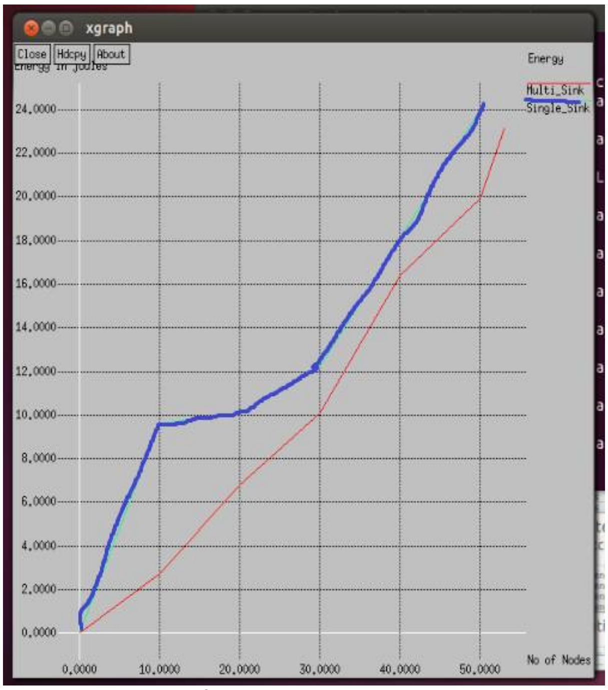

Figure 9: Energy of Single sink vs Multi Sink

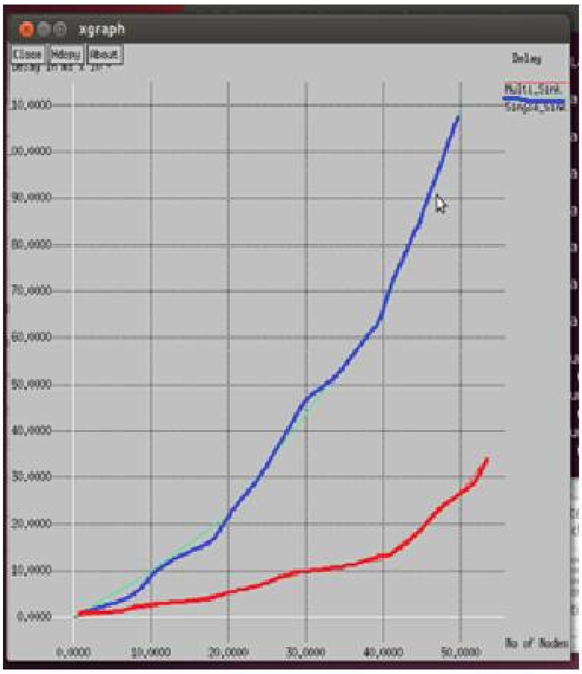

Figure 10: Delay of Single sink vs Multi Sink

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VIII. Conclusion and Future Work

The Multi Sink Protocol placed in the wireless sensor network helps to solve the Hot Spot Problem. The Energy problem in the sensor nodes can be optimized by using more than one sink. Simulation results showed that the proposed algorithm performs better with the total transmission energy metric than the maximum number of nodes metric. The proposed algorithm also provides efficient consumption of Energy and also less delay in data transmission and maximizes the lifetime of entire network. In the Future work the sinks can fixed at certain points and analyze the performance of the network.

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