Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X
IMPACT FACTOR: 5.258

IJCSMC, Vol. 5, Issue. 3, March 2016, pg.740 – 749

Improve Network Lifetime by using High Energy First Clustering Hierarchy Algorithm

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Abstract— Wireless sensor network (WSN) requires robust and energy efficient communication protocols to minimize the energy consumption as much as possible. However, Radio irregularity and fading in multi-hop WSN are the two main reasons because of what the lifetime of the sensor network reduces. In order to solve this problem a Cluster-based scheme was proposed. The proposed scheme extends High Energy First (HEF) clustering algorithm and enables multi-hop transmissions among the clusters by incorporating the selection of cooperative sending and receiving nodes. The performance of the proposed system is evaluated in terms of energy efficiency and reliability. Simulation results show that Hard network lifetime scheme is adopted among the clusters to achieve a tremendous energy saving. The network lifetime has been prolonged by the cooperative MIMO scheme with a 75% of nodes remaining alive as compared to LEACH protocol. In mobile adhoc networks, batteries are usually used to power up the nodes with limited energy. To prolong the network life, the energy consumption of the routing task is very important. In previous works, many topology control methods were provided to support the energy-efficient routing, while the most of them are designed for static network. In this paper, a novel topology control scheme is proposed for mobile nodes. Adhoc on demand distance vector routing protocol is specially designed for mobile adhoc networks with reduced overhead using Expanding Ring Search technique. Energy consumption is a fact to be considered in MANET due to battery constrain of the nodes.

Index Terms— WSN, HEF, MIMO, LEACH, MANET

I. INTRODUCTION

A wireless sensor network (WSN) consists of sensor nodes and these sensor nodes are capable of collecting information from the environment and communicating with each other via wireless transceivers. Generally, via multi-hop communication, the collected data will be delivered to one or more sinks. The sensor nodes are typically expected to operate with batteries and are often deployed to not-easily-accessible or hostile environment, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes. On the other hand, the sink is typically rich in energy. Efficient utilization of the energy to prolong the network lifetime has been the focus of much of the research on the WSN, as the sensor energy is the most precious resources in the Wireless Sensor Network. The communications in the WSN has the many-to-one property in that data from a large number of sensor nodes tend to be concentrated into a few sinks. Since multi-hop routing is generally needed for distant sensor nodes from the sinks to save energy, the nodes near a sink can be burdened with relaying a large amount of traffic from other nodes.

Sensor nodes are resource constrained in term of energy, processor and memory and low range Communication and bandwidth. Limited battery power is used to operate the sensor nodes and is very difficult to replace or recharge it, when the nodes die. This will affect the network performance. Energy conservation and harvesting increase lifetime of the network. Optimize the communication range and minimize the energy usage, we need to conserve the energy of sensor nodes .Sensor nodes are deployed to gather information and desired that all the nodes works continuously and transmit information as long as possible. This address the lifetime problem in wireless sensor networks. Sensor nodes spend their energy during transmitting the data, receiving and relaying packets. Hence, designing routing algorithms that maximize the lifetime until the first battery expires is an important consideration. Designing energy aware algorithms increase the lifetime of sensor nodes. In some applications the network size is larger required scalable architectures. Energy conservation in wireless sensor networks has been the primary objective, but however, this constrain is not the only consideration for efficient working of wireless sensor networks. There are other objectives like scalable architecture, routing .A latest version of LEACH protocol called the HEF protocol is used. In most of the applications of wireless sensor networks are envisioned to handled critical scenarios where data retrieval time is critical, i.e., delivering information of each individual node as fast as possible to the base station become an important issue. It is very important to make sure that the information is successfully received at the base station the first time instead of being retransmitted. In wireless sensor network, data gathering and routing are challenging tasks because of their dynamic and unique properties. Many routing protocols are developed, but among those protocols cluster based routing protocols are energy efficient, scalable and prolong the network lifetime .In the event detection environment nodes are idle most of the time and active at the time when the event occurs. In LEACH protocol we attain 50% energy efficiency, but in HEF protocol we can obtain a higher energy efficiency of 70%.Sensornodes periodically send the gathered information to the base station. Routing is an important issue in data gathering sensor network, while on the other hand sleep-wake synchronization are the key issues for event detection sensor networks.

II. PROPOSED SYSTEMS

Cluster heads are selected according to the probability of optimal cluster heads determined by the networks. After the selection of cluster heads, the clusters are constructed and the cluster heads communicate data with base station. Because LEACH is only depend on probability model, some cluster heads may be very close to each other and can be located in the edge of the WSN. These disorganized cluster heads could not maximize energy efficiency. This is one of the major defect of LEACH protocol and in order to overcome this defect, a cluster head election method HEF algorithm has been introduced. By using fuzzy variables (concentration, energy and density), the network lifetime can be efficiently increased with the help of HEF algorithm. Providing a trustworthy system behavior with a guaranteed hard network lifetime is a challenging task to safety-critical and highly-reliable WSN applications. For mission critical WSN applications, it is important to be aware of whether all sensors can meet their mandatory network lifetime requirements. The High Energy First (HEF) algorithm is proven to be an optimal cluster head selection algorithm that maximizes a hard N-of-N lifetime for HC-WSNs under the ICOH condition. Then, we provide theoretical bounds on the feasibility test for the hard network lifetime for the HEF algorithm. Our experiment results illustrates that the HEF algorithm achieves a significant performance improvement over LEACH protocol, and the lifetime of HEF can be bounded.

III. ARCHITECTURAL BLOCK DIAGRAM

Step 1: After starting the network, the wireless sensor nodes will be divided into several clusters in the WSN.

Step 2: A node will be chosen as the cluster head amongst the nodes in each cluster area. This cluster head will use a negotiation system to send joining messages to the nodes near the cluster head.

Step 3: After that, the cluster-heads will send invitations to the wireless sensor nodes in each cluster asking them to join the cluster-heads to form the clusters. The second phase includes the transferring data process and the distributing the role of cluster head process including the following three steps. The AODV routing protocol is responsible for sending the data from the source to the destination nodes. Based on the weight value, regularly selecting a set of new cluster heads determines the role of distribution.

ARCHITECTURE:

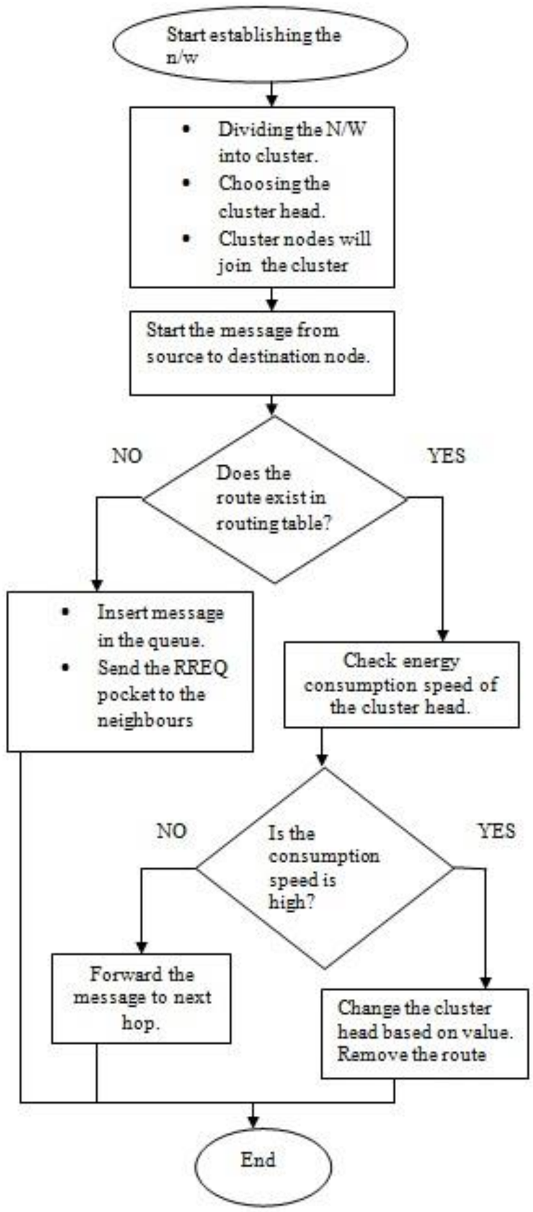

Fig1: Architectural Block Diagram

Step 4: When any wireless sensor node wants to send a message, the sensor node checks for the routing table and searches a path to the destination node. Therefore, if the route is available in the routing table, the message will be forwarded to the next node. Otherwise, the message will be saved in a queue, and the source node will send the RREQ packet to its neighbours to start up the discovery process.

Step 5: During the forwarding of the message to the destination, the power consumption rate of the cluster head will be calculated based on the energy model. If the speed of the energy consumption is high, then based on the value another node will be chosen as the cluster head .

Step 6: Then, the procedure will remove the route from the routing table of the source, which will lead the source node to initiate the discovery process in phase 2 again and a new path to the destination node through the new cluster head.

IV. MODULES

A. CLUSTER HEAD SELECTION:

The cluster heads may be special nodes with higher energy or normal node depending on the algorithm and application. Here base station is a cluster head performs computational functions such as data aggregation and data compression in order to reduce the number of transmission to the base station (or sink) there by saving energy. One of the basic advantages of clustering is that the latency is minimized compared to flat base routing and also in flat based routing nodes that are far from the base station lacks the power to reach it. The basic principle of its efficiency is that it operates on the rule of divide and conquers. Clustering along with reduction in energy consumption improves bandwidth utilization by reducing collision. Work is currently underway on the energy efficiency in WSNs which will result from the selection of cluster heads.

B. ENERGY CONSUMPTION:

Transmission in WSNs is more energy consuming compared to sensing, therefore the cluster heads which performs the function of transmitting the data to the base station consume more energy compared to the rest of the nodes. Clustering schemes should ensure that energy dissipation across the network should be balanced and the cluster head should be rotated in order to balance the network energy consumption.

C. ENERGY EFFICIENT ROUTING:

In contrast to simply establishing correct and efficient routes between pair of nodes, one important goal of a routing protocol is to keep the network functioning as long as possible. As discussed in the Introduction, this goal can be accomplished by minimizing mobile nodes' energy not only during active communication but also when they are inactive.

Transmission power control and load distribution are two approaches to minimize the active communication energy, and sleep/power-down mode is used to minimize energy during inactivity.

V. PROPOSED WSN STRUCTURE

A special resource reachable node called server node (SN) is introduced. It has the ability to cover long transmission range.

Server node (SN) is deployed in a location where all the nodes of each cluster are easily reachable. If it is not reachable, it is recommended to add another server node (SN).Due to extra processing capability sever node (SN) are responsible for selecting cluster head from candidate nodes. The sensor nodes operation in a cluster are closely monitored by introducing the server nodes and make them do specific operations. The purpose of introducing SN is to closely monitor the operation of sensor nodes in a cluster and command them for specific operations.

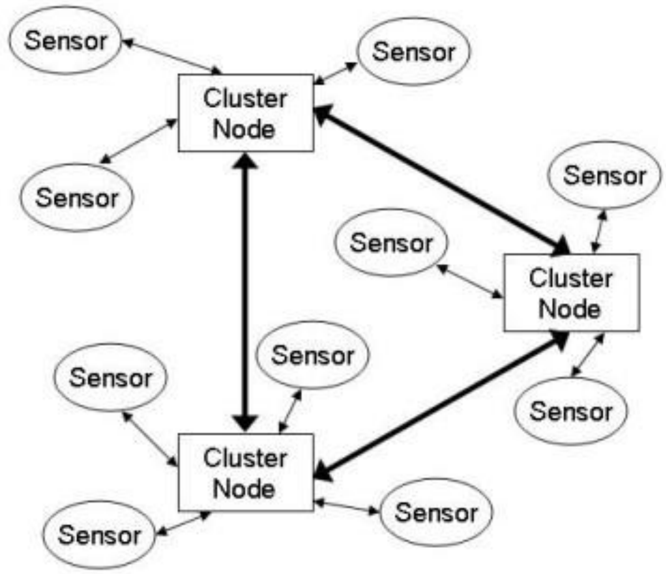

Fig.2: Proposed WSN Structure

VI. SELECTION OF MEMBER FOR CLUSTER HEAD

When there is an uneven distribution of sensor nodes in clusters, the cluster head selection becomes highly challenging. In order to make the cluster head (CH) selection algorithm more accurate, we first identify the candidate sensor nodes for cluster head and then select the best among them. In order to select candidate cluster heads from each cluster use the K-theorem. The candidate cluster head is selected based on the bunch of sensor nodes and this main theme behind the K-theorem.

Each cluster is given a value by the Sensor node. The value is relative to the node density in a cluster and ratio of the cluster heads in a WSN. It is the product of the number of nodes in a cluster and ratio r. The value varies from 0.01 to 0.99 but not greater than 0.50. The lesser the value of, the greater the probability of getting a local optimal is. The value determines the number of best sensor nodes as candidate CHs. For each sensor node deployed in the cluster, we choose its nearest neighbors based on distance. The distance between sensor nodes can be calculated through received signal strength indicator (RSSI) that is described or any other localization technique. When the number of immediate (1-hop) neighbors is less than and distance is greater than the transmission range then multi-hop route is preferred. Multi-hop route is preferred over direct because of less energy consumption.

The server node (SN) adopts the procedure detailed below in order to select candidate CHs for each cluster. The server node (SN) maintains a table for each cluster, listing all the sensor nodes present in the cluster. It maintains nearest neighbors for each node and the frequency of occurrence of each node is maintained in the table.

VII. CLUSTER-BASED SENSOR NETWORK

There are two different kinds of sensors in the network. Sensor acts as the cluster head and other sensors play the role of cluster members. The message transmitted from the cluster members to the cluster head are constrained to the bits. Each cluster member quantizes its observation to bits and sends the quantized data to the cluster head. The cluster head performs source extraction based on its own observation and the received quantized data from the cluster members. If the distribution of the observations or sources are known, the optimal quantization rule may be derived. However, the distribution of sources are not specified in this work so as to accommodate different kinds of sources. Besides, the distributions may not be known a priori. The computational capability of the sensors are limited.

VIII. ENERGY CONSUMPTION MODEL

HEF provides optimal cluster head selection with respect to network lifetime under the ICOH condition. Now, we are ready to address the key characteristic, and the deterministic predictability for a hard network lifetime of WSN. The amount of energy consumed by a sensor node depends on the role it serves, as well as the workload it handles. To analyze hard network lifetime for guaranteed schedulability, the worst-case energy consumption (WCEC) analysis is used. and the minimum energy consumed for a cluster head, and a regular node in around respectively. the energy consumption model does not consider energy consumed on the initialization tasks, and the failure routines. In other words, we assume a certain reserved energy for these events. To obtain analytical results about the network behaviors ofHC-WSN when HEF is used in a hard network lifetime environment. Hard network lifetime constraint of the timeliness analysis can be satisfied by the evaluation of the worst case temporal guarantees. In such frame works, energy consumption for computational and communication loads are supposed to be bounded and known in order to obtain the worst-case conditions. To obtain the energy consumption bound analytically, a specific system model is investigated. In particular, this section focuses on a model for energy consumption estimation in HC-WSNs. As mentioned previously, the more information that is available about the WSN operating environments (such as topology and contexts of other nodes), and the system behaviors (such as clustering algorithms), the more rigorous are the bounds of the system performance that can be found. Data are sensed and transmitted in each round periodically.

IX. CLUSTER FORMATION PHASE

In this phase, clusters are organized and cooperative MIMO nodes are selected according to the steps described below:

1) Cluster head advertisement

Initially, when clusters are being created, each node decides whether or not to become a cluster head for each round as specified by the original LEACH protocol. Each self-selected cluster head, broadcasts an advertisement (ADV) message using non-persistent carrier sense multiple access (CSMA) protocol. The message contains the header identifier (ID).

2) Cluster setup

Each non-cluster head node chooses one of the strongest received signal strength (RSS) of the advertisement as its cluster head, and transmits a join-request (Join-REQ) message back to the chosen cluster head. The information about the node's capability of being a cooperative node, i.e., its current energy status is added into the message. If a cluster head receives the advertisement message from another cluster head y, and if the received RSS exceeds a threshold, it will markcluster head y as the neighboring cluster head and it record ID. If the sink receives the advertisement message, it will find the cluster head with the maximum RSS, and sends the sink-position message to that cluster head marking it as the target cluster head (TCH).

3) Cooperative node selection

After the cluster formation, each cluster head will select J cooperative sending and receiving nodes for cooperative MIMO communication [5] with each of its neighbouring cluster head. Nodes with higher energy close to the cluster head will be elected as sending and receiving cooperative nodes for the cluster. At the end of the phase, the cluster head will broadcast a cooperative request (COOPERATE-REQ) message, which contains the ID of the cluster itself, the ID of the neighboring cluster head y, the ID of the transmitting and receiving cooperative nodes and the index of cooperative nodes in the cooperative node set of each cluster head to each cooperative node. The cooperative node on receiving the COOPERATE- REQ message, stores the cluster head ID and sends back a cooperate-acknowledgement (ACK) message to the cluster head.

X. DATA TRANSMISSION PHASE

During this phase, the data sensed by sensor nodes are transmitted to the cluster head and forwarded to the sink using multi-hop MIMO scheme according to the routing table.

1. Intra cluster transmission:

In this phase, the non-cluster head nodes send their data frames to the cluster head as in LEACH protocol during their allocated time slot. The duration and the number of frames are same for all clusters and depend on the number of non-cluster head nodes in the cluster.

2. Inter cluster transmission:

After a cluster head receives data frames from its cluster members, it performs data aggregation and broadcasts the data to cooperative MIMO sending nodes. When each cooperative sending node receives the data packet, they encode the data using space time block code (STBC) and transmit the data cooperatively. The receiving cooperative nodes use channel state information to decode the space time coded data. The cooperative node relays the decoded data to the neighboring cluster head node and forwards the data packet to the TCH by multi-hop routing.

XI. SCHEDULABILITY ANALYSIS OF HEF

The most important property of the WSN network lifetime is not longevity, but predictability. Schedulability tests are essential for the time-critical system because it provides predictability to complement online scheduling. Cluster head selection algorithms produced by empirical techniques often result in highly unpredictable network lifetimes. Although an algorithm can work very well to prolong the network lifetime for a period of time, a possible failure can be catastrophic, resulting in the failure of a mission, or the loss of human life. A reliable guarantee of the system behaviors is hence a requirement for systems to be safe and reliable. However, there are currently no known analytical studies on the network lifetime predictability for cluster head selection algorithms. apply the worst-case energy consumption analysis to derive the predictability of HEF.

A. HEF ALGORITHM

HEF selects the set of M highest ranking energy residue sensors for cluster heads τ at round where M denotes the required cluster numbers at round τ [1]. HEF is designed to select the cluster head based on the energy residue of each sensor to create a network-centric energy view. Intuitively, HEF is a centralized cluster selection algorithm.

B. Operation of HEF

The interactions and detailed operations between components are discussed as follows.

1) HEF selects cluster heads according to the energy remaining for each sensor node, and then the “setup” message (indicating cluster members, and the cluster head ID for each participated group) is sent to the cluster head of each cluster.

2) The cluster head of each group broadcasts the “setup” message inviting the neighbor sensor nodes to join its group.

3) After receiving the “setup” message at this round, the regular sensors send the “join” message to its corresponding cluster head to commit to associate with the group.

4) Upon collecting cluster members’ information at a given period, the cluster head sends the summative report to the base station.

XII. SIMULATION RESULTS

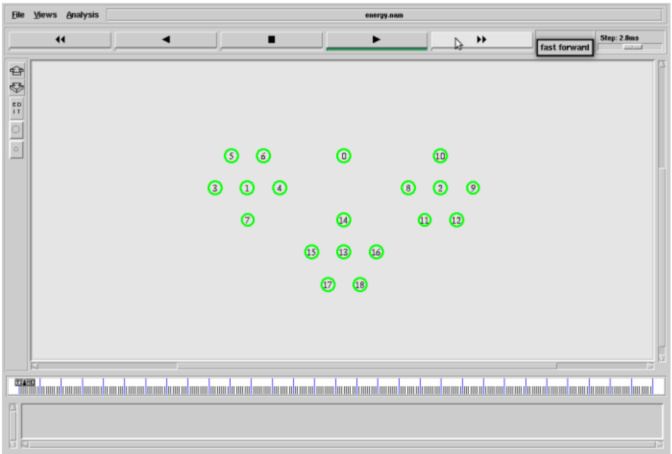

Fig.3 Network Formation

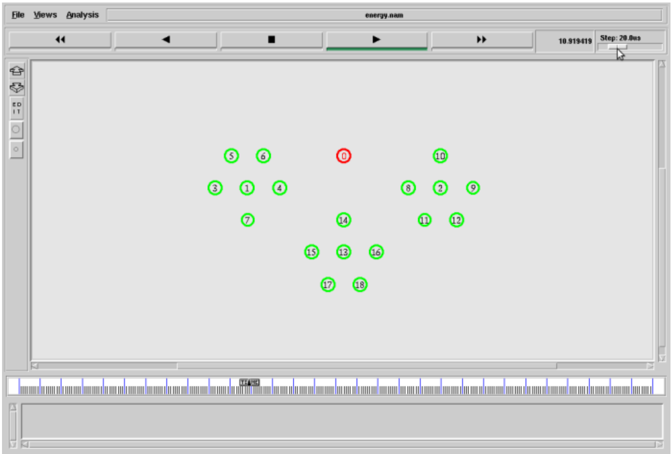

Fig.4 Cluster Head Selection

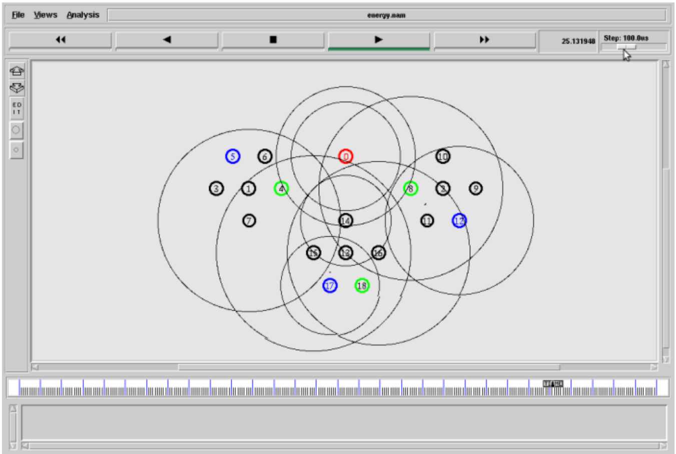

Fig.5 Data to cluster

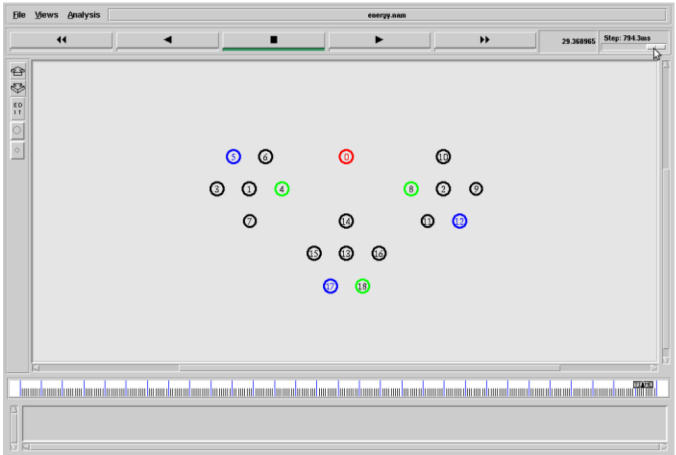

Fig. 6 Data to Sink

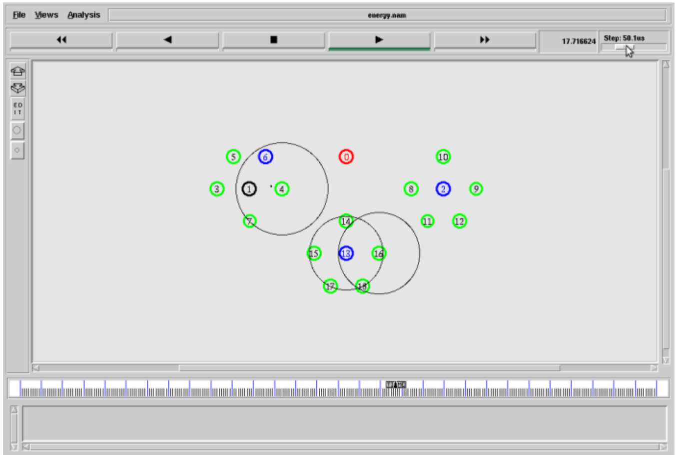

Fig.7 Cluster change 1

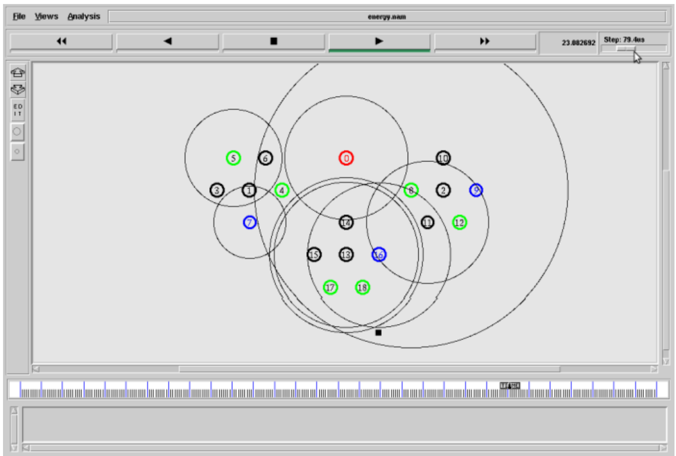

Fig.8 Cluster change 2

CONCLUSION:

We have addressed the issue of the predictability of collective timeliness for WSNs of interests. First, the High Energy First (HEF) algorithm is proven to be an optimal cluster head selection algorithm that maximizes a hard N-of-N lifetime for HC-WSNs under the ICOH condition. Then, we provide theoretical bounds on the feasibility test for the hard network life-time for the HEF algorithm. Our experiment results show that the HEF algorithm achieves significant performance improvement over LEACH, and HEF's lifetime can be bounded.

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