

LEACH Enhancement for Military Security Operations

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Abstract

The Wireless Sensor Network (WSN) is very diverse area of research in current era. It is attracting researchers due to its massive usage in several daily application as well as specific applications such as disaster sensing, battle zone perception and harm occurrence. The WSN uses nodes to sense certain physical events. Due to advent of smart systems for sensors' data manipulation and connectivity, WSN offers better flexibility and become key technology for military applications. WSN plays an important role in security of military operations. The WSN has many protocols one of them is LEACH protocol has some issues to sense the security operations for military such as Battlefield Surveillance, Reconnaissance of opposing forces and physical object tracking and targeting. Therefore WSN military security sensing needs more sophisticated protocols, modified system architecture to perform the job for security sensing for military.

Keywords:

WSN Leach Protocol, Military Operations, Leach Operations.

1. Introduction

The WSN network is vast area of research in today's time. Researchers are moving toward it due to its application in the areas where the human can't reach. The WSN is used as key to measure the different environmental conditions such as Temperature, Object tracking, Security sensing and control, disaster sensing and Military Operations Battlefield surveillance and monitoring, guiding systems of intelligent missiles and detection of attack by weapons of mass destruction, Reconnaissance of opposing [1, 2]. The WSN is a group of transducers with a communication infrastructure to monitoring and recording conditions at different Locations. Wireless Sensor Network is used to monitor an environment and record the Data [1]. The WSN sense the events with the employ of tiny size Nodes. These nodes need battery power to sense the event and do apposite action. The battery power is an issue in the WSN network. In WSN different protocols use for the battery power saving and sensing event [2]. LEACH protocol is one of all these protocols.

LEACH can be use for military security operations such as such as Battlefield surveillance and monitoring, guiding systems of intelligent missiles and detection of attack by weapons of mass destruction, Reconnaissance of opposing forces and physical object tracking and targeting etc but LEAHC has some drawbacks such as cycle creation, energy consumption, protocol's deployment, CH finalizing

for next round. LEACH is a routing protocol and use for the WSN network long span [5]. Due to which it is not ingenious for the military security operations.

2. LEACH (Low-Energy Adaptive Clustering Hierarchy):

LEACH (Low-Energy Adaptive Clustering Hierarchy) is one of the WSN protocols use for the energy efficiency. LEACH is a clustering routing protocol. The LEACH protocol is TDMA based MAC protocol. The basic intention of use of the protocol is to enhance the lifespan of the WSN network by lowering energy consumption. In the clustering framework there should be a Cluster Head (CH) and Cluster Members (CM), these cluster members are Sensor Nodes. The CH collects the data from the other CM and sends it to Base station. CH allocates energy to nodes in the network to organize the energy but CH itself takes more energy than the nodes. CH elects after the voting of the nodes and it happens in every round because if one CH takes position for long time then it will die. In the LEACH when the cluster formed then the CH generate TDMA schedule for its CM in cluster and choose CSMA code. CH then sends the TDMA schedule table to its cluster members [3, 4, 5].

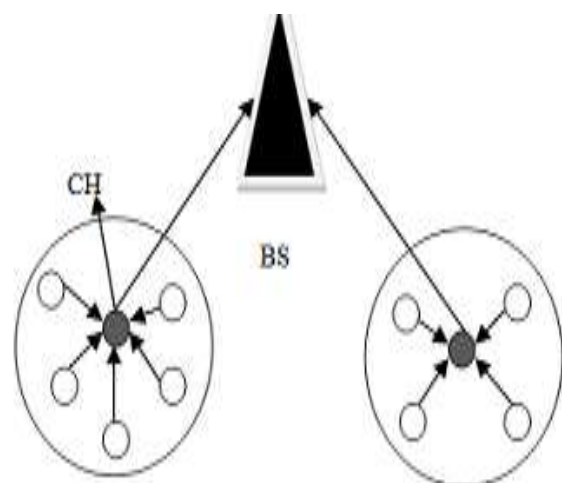


Figure 1 LEACH Protocol [8]

3. LEACH Operation

The operation of the LEACH protocol consists of two rounds Set-Up phase and Steady Phase [4, 6, 8].

3.1 Set-Up Phase:

The Set-Up phase is the one round cycle of LEACH protocol. In this phase time span is less than the Steady Phase. For the performing of the phase it has three steps [7]:

- Cluster Head Advertisement.
- Cluster Set up.
- Creation of Transmission Schedule.

The cluster head sends the advertisement packets to CM to inform them that they can also become CH. The CH sends the advertisement with the use of CSMA MAC protocol. All CM in the round keep on their receivers for receive the advertisement from the cluster head [6, 7, 8].

After the receiving of the message the CM response to the CH in the form of join request to inform the CH that it is also member of the cluster. When the one round complete then the next CH is decided on the basis of the high signal strength, if there is tie between the two CM then the random CH decide. All CH have to keep on there receivers for receive the join request from CM [7, 8, 10].

The transmission of data is done by TDMA schedule, CH creates schedule. The schedule is created according to the number of nodes in the cluster. Each node sends data to the CH within the allocated time by the CH to node. In the remaining time the node keep its receiver off to save energy for network long lifespan [6, 7, 8].

3.2 Steady Phase

The steady phase of LEACH is longer than the Set-up phase. Ultimately it results in the form of less or unnecessary cost of the network. In the steady phase the all CM sends data to CH and CH aggregates data and decrease the amount of data to minimize the load and save energy in network. The CM sends data via a single hop. After the receiving and reducing the size of data the CH directly sends data to base station or send via a neighbor CH. The purpose of transmission of data via neighbor CH is to find the shortest route to base station for save energy. After a decided time the network again goes back into the Ste-Up state for new cluster, CH and CM [4, 7, 10]. The entire operation of the LEACH protocol is explained via the diagrams shown below.

The Figure 2 shows that the CH send Advertisements message to all CM via CSMA protocol in the cluster and invites them to become next CH in the new cluster. The Figure 3 is explaining the creation of the cluster. The CM sends join request to CH to become part of the cluster.

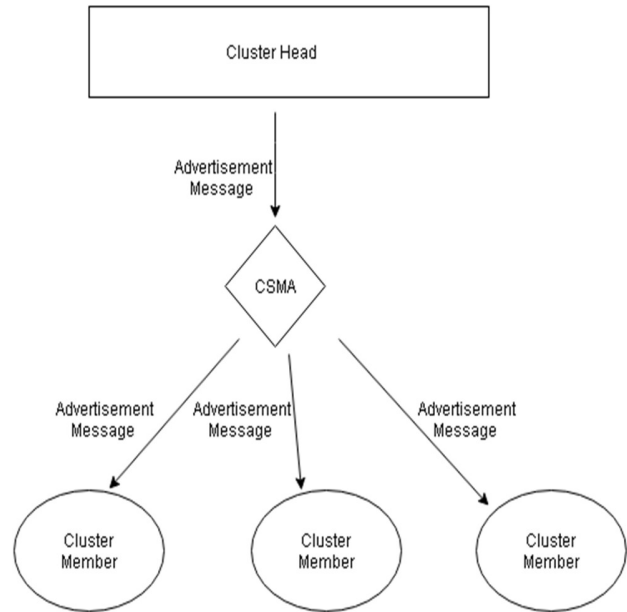


Figure 2 CH Advertisement Message to CM in Cluster

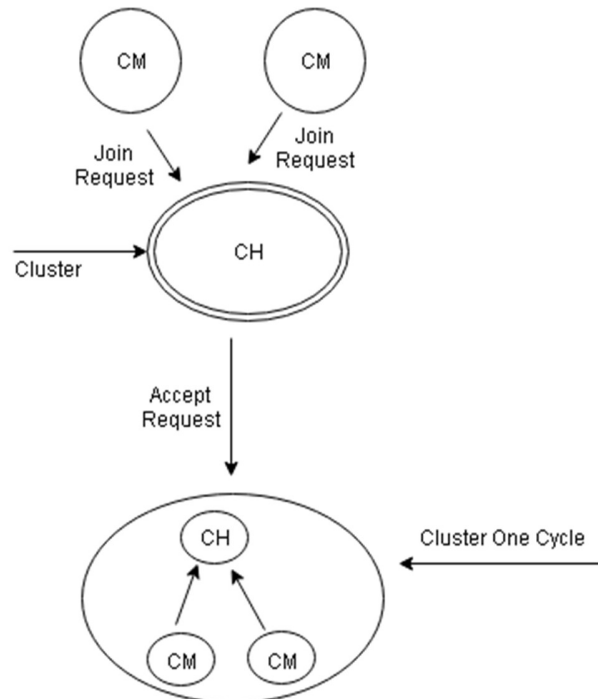


Figure 3 CM Sending Request to CH for joining Cluster

The Figure 4 is explaining the sending of data of one cluster's CH via neighbor CH to save the energy. As in the diagram the CH has two routes to send information to base station route 1 and route 2. The CH has to decide that which one is the shortest path and can save energy. The CH

needs time to find out the shortest path and location of its neighbor CH therefore the CH can send data proficiently.

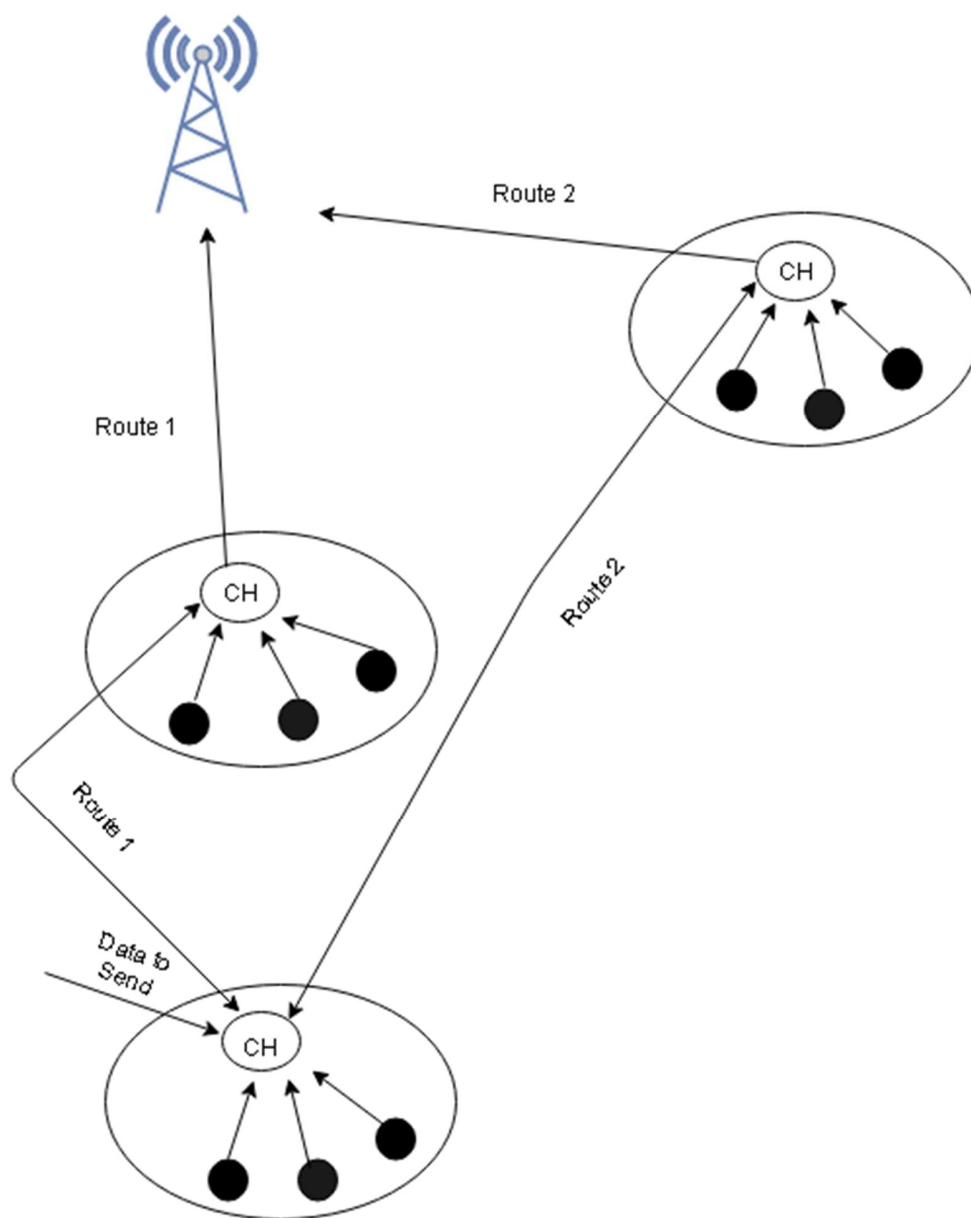


Figure 4 Neighbor Route to send Data

The Figure 5 is explaining that how the CH distributes the time slots between the CM in the cluster for sending data. The time and energy is equally divided

between CM in cluster. CH gathers data from CM and then sends to base station.

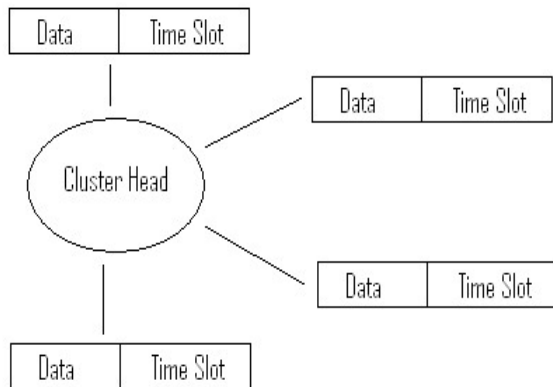


Figure 5 Cluster Member Send Data with Allocated Time Slot

4. LEACH for Military Operation

Military operations necessitate some WSN protocol to track and target the operations such as Battlefield surveillance and monitoring, guiding systems of intelligent missiles and detection of attack by weapons of mass destruction, tracking suspicious things, equipments sensing and tracking, in the battle field target the enemies etc. In the military environment the protocol has to be on job all the time to sense the environment with the less use of the energy. For these operations LEACH is not pertinent protocol due to following drawbacks [5, 7, 13, 14]:

1. The most significant and somber aspect of the LEACH is the sending of data via neighbor node in the cluster network. As shown in the above Figure 4 the CH has to find the shortest path for sending data to base station via neighbor node. Due to this LEACH is not appropriate for military security sensing and events for the reason when CH find the shortest path then it takes time to find the best neighbor with short distance from the base station as the time increase to find the path ultimately the time increase to take the action against the event occur or information receive from CH.
2. The other issue in the LEACH protocol is the time required for selection of the next CH in cluster. As shown below the equation for selection of the next CH for next cycle. But the main issue with LEACH is no specification of the time period for CH selection. The formula is only working for the threshold value and comparing nodes on basis of value then elect the next CH for next round. When protocol is electing

and on other side the event trigger then how the WSN protocol will sense the event and how will take appropriate action to save from disaster. Will the WSN network complete the next CH selection or take action with the current CH?

$$T(n) = \begin{cases} p/1-p*(r \bmod 1/p) & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

If the LEACH protocol completes CH selection process and then takes action therefore possible that the event trigger and complete before the elect of next CH and disaster occur.

3. In the Figure 5 CH equally distribute the time slots and energy between the CM in the network. The equal distribution of the energy and time is an issue because in the WSN networks some CM is close to CH and some far from CH. The CM close to CH can send data with the less use of energy and the far CM require more energy to send data. Therefore when the far distance CM has to send data and need more energy to send then might be possible that the data delivery become fail. In military operations any where event can occur. There is no chance of data delivery fail in military operations on the basis of distribution of time and energy in LEACH.
4. In the LEACH the CH receive data from all CM in the cluster then filter data and send it to base station. The data aggregation and then send to base station is drawback in the LEACH. When the event trigger at one CM side and others CM has no data to send then at this situation will the CH receive single CM data and send it to base station to take appropriate action? Or CH will receive the empty data packets from the other CM, aggregate data and send to base station. In both these two situation the energy will waste, delay in apposite action and low resource management.
5. The LEACH protocol does not cover the large area for sensing. In the military operation there is no boundary of network deployment. The WSN can be deploy for the large area to sense and make it secure.
6. The LEACH protocol any cluster becomes useless when its CH dies. It does not gather data from that cluster's CM. Therefore if unfortunately in the battle field the CH of very sensitive cluster dies then the whole battle field will become oppose to our military.

Therefore due to all these issues in the LEACH protocol it is not suitable protocol for the military security sensing.

5. Conclusion and Future Directions

WSN network is the well-liked area of interest. Many researchers are moving to it. LEACH is one of protocol in WSN network. LEACH is a routing protocol and is used for the energy efficiency but it has some drawbacks due to which it is not applicable for the military security operations. These drawbacks are related to CH selection, time distribution, distance of CM from CH, CH data aggregation and then sending to base station. The LEACH protocol needs some modification for military security deployment. The future directions for the LEACH protocol:

1. Modified the protocol with the distribution of energy and time with the highly sensitive and data rate nodes in the cluster.
2. Distribute the time and energy according to distance of the nodes in the cluster.
3. Inform the CM (Nodes) about the locations of the other nodes in the network therefore whenever any node need to find the shortest path then will be easy to find and energy will save.
4. Modify the architecture of the LEACH protocol for large scale area therefore it will become able to deploy for military security sensing.
5. Introduce the formula for energy distribution and CH selection for next round.
6. Introduce some calculation to specify/Set the time period for selection of CH for next round.
7. Modify the protocol with the concern that when selection of CH is under process then how network will track and sense.
8. Prioritized the nodes in the cluster according to sensitivity of their deployment and then distribute the energy.
9. Individual receiving of data from single CM in the cluster and send to base station.

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