**TLEACH in WSN**

**Software:** NetSim Standard v14.0, Visual Studio 2022

**Project Download Link:**

Follow the instructions specified in the following link to download and set up the Project in NetSim:

<https://support.tetcos.com/en/support/solutions/articles/14000128666-downloading-and-setting-up-netsim-file-exchange-projects>

**Introduction:**

Low-energy adaptive clustering hierarchy ("LEACH")is a [MAC](https://en.wikipedia.org/wiki/Media_access_control) protocol that is integrated with clustering and a simple routing protocol in [wireless sensor networks](https://en.wikipedia.org/wiki/Wireless_sensor_network) (WSNs). The goal of LEACH is to lower the energy consumption required to create and maintain clusters to improve the lifetime of a wireless sensor network.

This Cross-Layer Protocol is implemented in NetSim in the MAC layer which involves ZigBee Protocol and the Network layer which involves DSR protocol. The clustering of sensors happens in the Network layer and the Cluster head election involves interacting with the MAC layer to obtain the remaining power of the sensors.

TLEACH is a Threshold-based LEACH in which nodes with remaining energy greater than a threshold value are considered to elect the cluster head. The sensor that is closer to the sink node is elected as the cluster head. Whenever all sensors in a cluster reach an energy level lower than the threshold, the threshold is reduced.

**Real-World Context:**

In the context of Precision Agriculture in large farms, various monitoring sensors are deployed to gather data on different aspects of the agricultural environment, such as soil moisture, temperature, Weather and crop health. In this example, we consider the TLEACH protocol. **T-LEACH (Threshold-sensitive LEACH)** is an energy-efficient clustering protocol for wireless sensor networks (WSNs) that is particularly well-suited for precision agriculture applications in large farms. It is an improvement over the original LEACH protocol. In this scenario, we consider Yield,Weather,Soil and Plant as clusters, representing different aspects of the farm's operations. By implementing the TLEACH protocol, we can effectively improve the lifetime of sensors and enhance the efficiency of data collection for precision agriculture in large farms.

**Soil Monitoring Cluster:** Gathers data on soil moisture, nutrient levels, and temperature.

**Plant Monitoring Cluster:** Collects data on plant growth and water stress.

**Weather Monitoring Cluster:** Measures temperature, humidity, precipitation, and wind .

**Yield Monitoring Cluster:** Estimates crop yield and improve agricultural productivity.

A diagram of different colored objects

Description automatically generated with medium confidence

Figure 1: Real World Agriculture Monitoring System.

**Implementation of TLEACH in WSN:**

A **TLEACH.c** file is added to the DSR project.

1. For this implementation of TLEACH, the number of Clusters is fixed as 4 and all the 4 clusters are equal. If the user wants to change it, then he/she must also change the static routing for the Cluster Heads and the Cluster Element array accordingly.

A screenshot of a computer program

Description automatically generated

Figure 2: TLEACH.c file

1. To make 4 equal clusters the number of sensors must be 4,16,36,64,100. Depending on the number of sensors, the Cluster Elements array must be defined. Here, it has been defined and commented for 4,16,36,64,100 sensors.
2. Uncomment the one you want to use. Change the number and size of the clusters in TLeach.c file .Create a new scenario in the same workspace and Drop the Number of sensors in GUI as mentioned in the comment in code.

The file contains the following functions:

* **fn\_NetSim\_TLEACH\_CheckDestination();** // This function is used to check whether the current device is the destination (i.e.) the sink node or not. Else the packet will be forwarded to the next hop.
* **fn\_NetSim\_TLEACH\_GetNextHop();** // This function is used to identify the next hop in cases where the current device is either a sensor within the cluster or the cluster head. Static routes are defined in this function. It returns the Device id of the next hop.
* **fn\_NetSim\_TLEACH\_AssignClusterHead();** // This function is used to dynamically assign cluster heads within a cluster based on the residual energy. The sensor with higher remaining power in comparison to other sensors within the same cluster will be elected as the cluster head.
* **fn\_NetSim\_TLEACH\_IdentifyCluster();** // This function is used to determine the cluster to which a sensor belongs. It returns the cluster id of the cluster.
* **fn\_NetSim\_TLEACH\_init();** // It is used to initialize TLEACH parameters such as the sink node ID and the initial Threshold value.
* **fn\_NetSim\_TLEACH\_set\_threshold(); //** It is used to reduce the threshold value for clusters whenever all sensors in a cluster reach energy levels less than the threshold.

**Example:**

1. The **TLEACH-in-WSN-Workspace** comes with a sample network configuration that is already saved. To open this example, go to Your work in the home screen of NetSim and click on the **TLEACH-in-WSN-Example** from the list of experiments.
2. The example consists of a WSN network with 64 sensors placed uniformly along with a sink node as shown below:

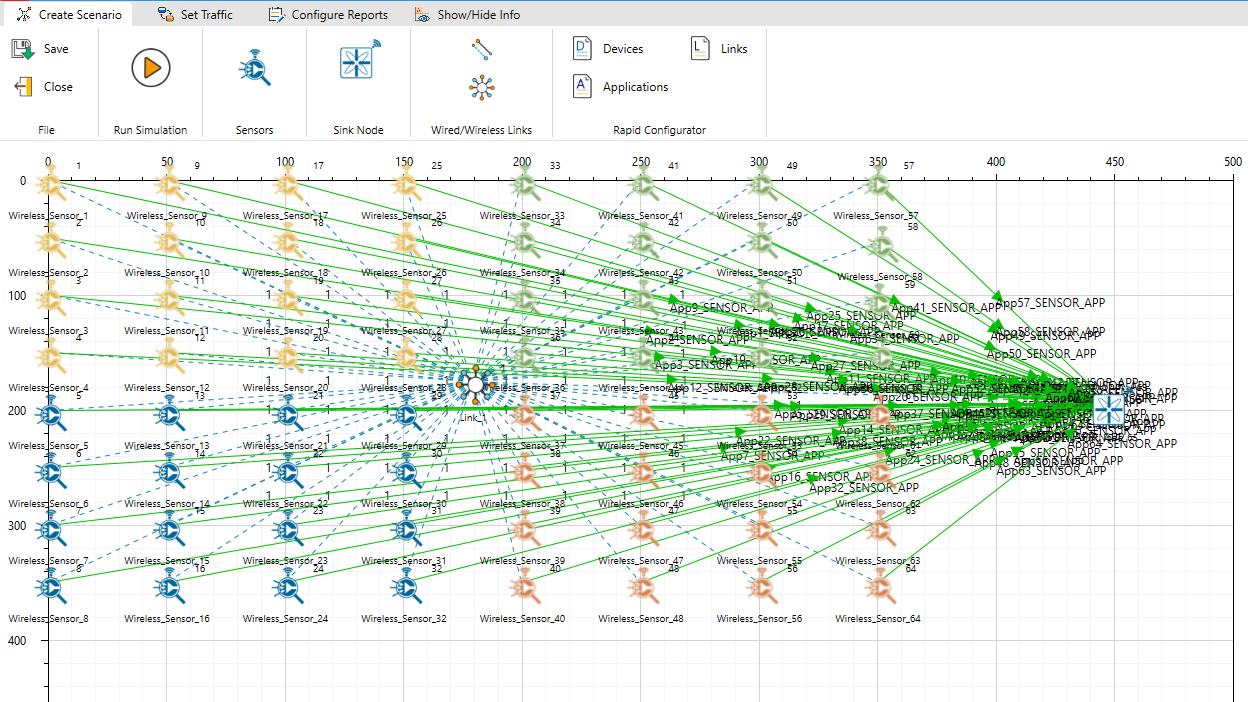


Figure 3: Network Topology

1. Run the Simulation for 500 Seconds.

**Results and discussion:**

In packet trace. You will note that the sensors directly start transmitting packets without route establishment since the routes are statically defined in TLEACH. You will also note that the cluster heads keep changing dynamically. If the sensor has more remaining energy than the threshold value. It will be elected as cluster head for transmitting the packets to the corresponding clusters.

The battery model table reveals that the consumed energy is significantly lower with TLEACH protocol implementation compared to without TLEACH. This can be observed in the battery model table.

**With TLEACH Protocol Implementation:**

A screenshot of a computer

Description automatically generated

Figure 4: Battery model table

**Without TLEACH Protocol Implementation:**

A screenshot of a computer

Description automatically generated

Figure 5: Battery model table

**Note:** You can observe slight variation in the Consumed energy with and without TLEACH protocol implementation.