

TLEACH in NetSim

Software: NetSim Standard v13.3, Visual Studio 2022

Project Download Link:

<https://github.com/NetSim-TETCOS/TLEACH-in-WSN-v13.3/archive/refs/heads/main.zip>

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>

Low-energy adaptive clustering hierarchy ("LEACH") is a MAC protocol that is integrated with clustering and a simple routing protocol in wireless sensor networks (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.

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.

```

28
29
30 #include "main.h"
31 #include "DSR.h"
32 #include "List.h"
33 #include "../ZigBee/802_15_4.h"
34 #define NUMBEROFCLUSTERS 4
35 #define SIZEOFCLUSTERS 16 //SIZEOFCLUSTERS can be 1,4,9,16,25
36 #define THRESHOLD_PROPORTION 0.7 //Threshold is set to 70% of the maximum battery level in the cluster
37
38 static int CHcount[NUMBEROFCLUSTERS];
39 static int prevCH[NUMBEROFCLUSTERS];
40 static int CHthreshold[NUMBEROFCLUSTERS]; //Contains the energy threshold value for each cluster
41
42 int sinkNodeID;
43 FILE *fp;
44 //For 100 sensors and SIZEOFCLUSTERS = 25, uncomment this
45 //int ClusterElements[NUMBEROFCLUSTERS][SIZEOFCLUSTERS] = {{1,2,3,4,5,11,12,13,14,15,21,22,23,24,25,31,32,33,34,35,41,42,43,44,45},\
46 {6,7,8,9,10,16,17,18,19,20,26,27,28,29,30,36,37,38,39,40,46,47,48,49,50},\
47 {51,52,53,54,55,61,62,63,64,65,71,72,73,74,75,81,82,83,84,85,91,92,93,94,95},\
48 {56,57,58,59,60,66,67,68,69,70,76,77,78,79,80,86,87,88,89,90,96,97,98,99,100}};
49
50 //For 64 sensors and SIZEOFCLUSTERS = 16, uncomment this
51 int ClusterElements[NUMBEROFCLUSTERS][SIZEOFCLUSTERS] = { {1,2,3,4,9,10,11,12,17,18,19,20,25,26,27,28},\
52 {5,6,7,8,13,14,15,16,21,22,23,24,29,30,31,32},\
53 {33,34,35,36,41,42,43,44,49,50,51,52,57,58,59,60},\
54 {37,38,39,40,45,46,47,48,53,54,55,56,61,62,63,64}};
55
56 //For 36 sensors and SIZEOFCLUSTERS = 9, uncomment this
57 //int ClusterElements[NUMBEROFCLUSTERS][SIZEOFCLUSTERS] = {{1,2,3,7,8,9,13,14,15},{4,5,6,10,11,12,16,17,18},{19,20,21,25,26,27,31,32,33},
58
59 //For 16 sensors and SIZEOFCLUSTERS = 4, uncomment this
60 //int ClusterElements[NUMBEROFCLUSTERS][SIZEOFCLUSTERS] = {{1,2,5,6},{3,4,7,8},{9,10,13,14},{11,12,15,16}};
61
62 //For 4 sensors and SIZEOFCLUSTERS = 1, uncomment this
63 //int ClusterElements[NUMBEROFCLUSTERS][SIZEOFCLUSTERS] = {{1},{2},{3},{4}};
64

```

Figure 1: TLEACH.c file

- 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.
- Uncomment the one you want to use. Change the number and size of the clusters in Leach.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 **Workspace_TLEACH_in_WSN** 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:

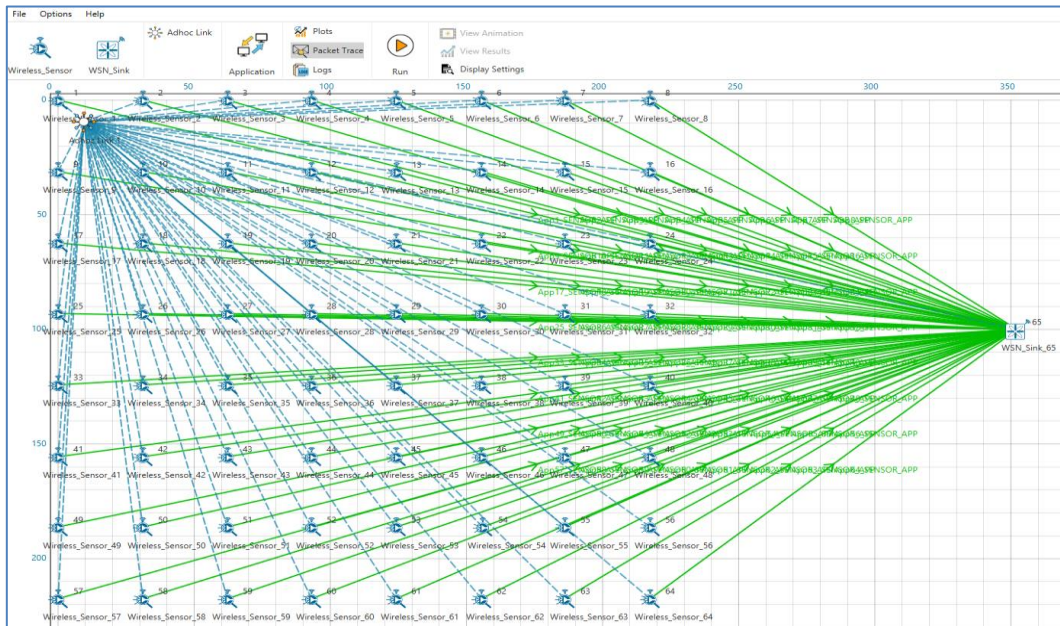


Figure 2: Network Topology

3. Run the simulation.

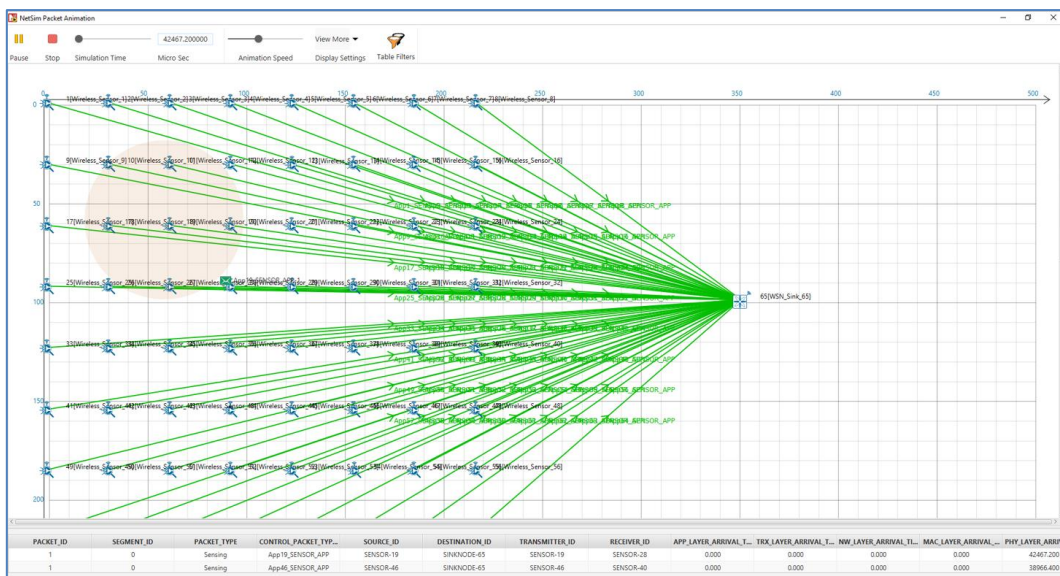


Figure 3: Packet animation window for TLEACH

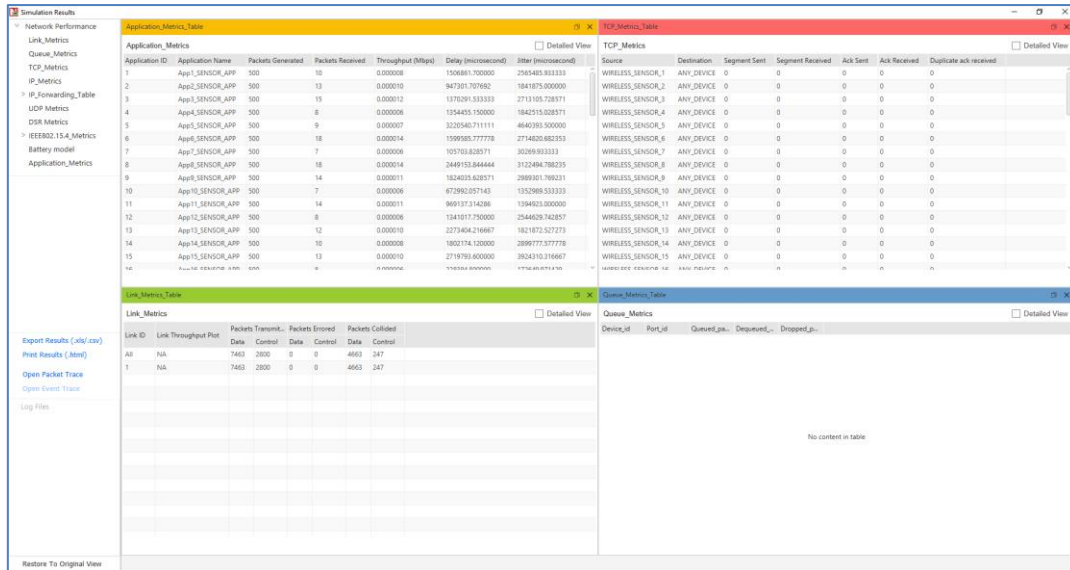


Figure 4: Result Dashboard

Results and discussion:

View the packet animation. 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 a cluster head for transmitting the packets to the corresponding clusters. User can enable the packet trace to see how exactly packets has been sent to the sink node.