Localization in WSN

Software Recommended: NetSim Standard v13.0 (32 bit/ 64 bit), Microsoft Visual Studio 2019

Project Download Link:

https://github.com/NetSim-TETCOS/Localisation_in_WSN_v13.0/archive/refs/heads/main.zip

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

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

Introduction:

Localization is the process of finding the physical or relative location of a sensor node as data and information are useless if the nodes have no idea of their geographical positions. GPS (global positioning system) is the simplest method for localization of nodes, but it becomes expensive if large number of nodes exists in each network.

Anchor Nodes:

Sensor nodes with known location information are called “Anchor nodes". Typically, anchor nodes obtain their location information by using a global positioning system (GPS), or by manually being placed at defined coordinates.

Unknown Nodes:

Sensor nodes with unknown location information are called “Non-Anchor nodes" or “Unknown nodes”. Localization is estimated through communication between localized node and unknown node for determining their geometrical placement or position. Location is determined by means of distance and angle between nodes.

Trilateration:

Location of node is estimated through distance measurement from three nodes. In this concept, intersection of three circles is calculated, which gives a single point which is a position of unknown node.

Use the distance equation. If your unknown point is (x, y) and known points are (x_i, y_i) which are at distances r_i from unknown point, then you get three equations:

$$(x-x1)^2+(y-y1)^2 = r1^2 \quad (x$$

$$-x2)^2+(y-y2)^2 = r2^2 \quad (x-$$

$$x3)^2 + (y - y3)^2 = r3^2$$

To calculate the distance between to sensors we have used NetSim API

```
DEVICE_DISTANCE(d1,d2)
```

Expand out the squares and subtract the second equation from the first and third equation from second, we get

$$2(x2 - x1)+ 2(y2 - y1)y = r1^2 - r2^2 + x2^2 - x1^2 + y2^2 - y1^2$$

$$2(x3 - x2) + 2(y3 - y2)y = r2^2 - r3^2 + x3^2 - x2^2 + y3^2 - y2^2$$

This is a system of two equations with two unknowns:

$$Ax + By = C$$

$$Dx + Ey = F$$

The values of x and y is obtained from the below equations:

$$x = (CE - FB)/(EA - BD)$$

$$y = (CD - AF)/(BD - AE)$$

Localization in NetSim:

1. To implement Localization, we have added **Localisation.c** file in Zigbee project. The file contains the following functions:

   - int fn_NetSim_localisation()

     This function is used to find the anchor nodes based on the highest received powers received at unknown sensors from anchor nodes.

   - int fn_NetSim_trilateration_method()

     This function is used to implement the trilateration method to calculate the position / location of the unknown sensor.

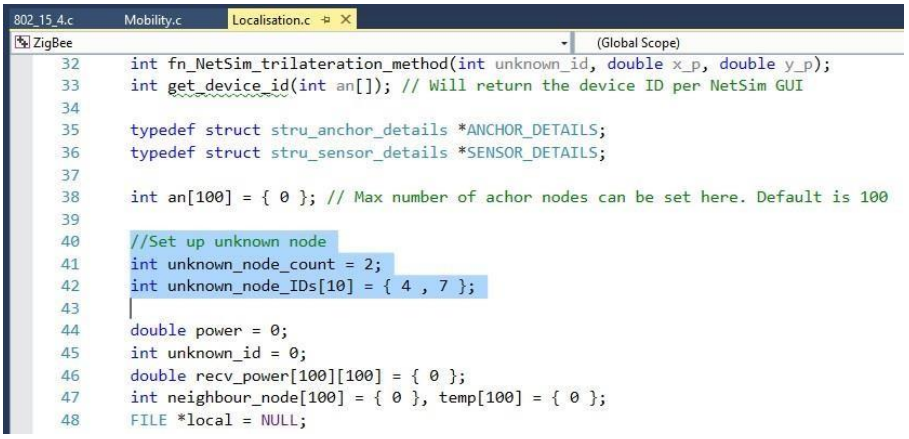
   - bool IsUnknownNode()

     This function is used to check whether the given node is unknown node or not.

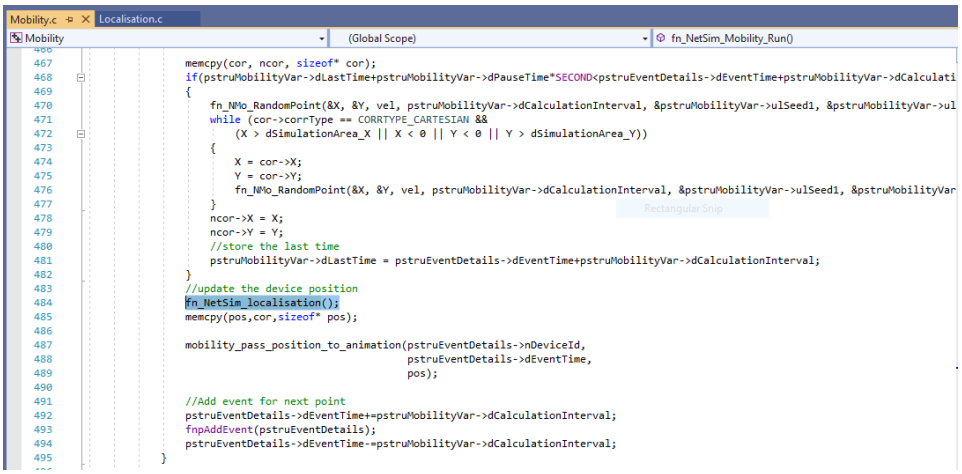
   - bool determine_anchor_node()

     This function is used to check whether the given node is anchor node or not.

2. Users can give their own unknown node IDs and unknown node count in **Localisation.c** file. NetSim knows all the positions of sensor nodes. Localization is used to find the position of unknown nodes and then comparing this position with NetSim sensor positions.

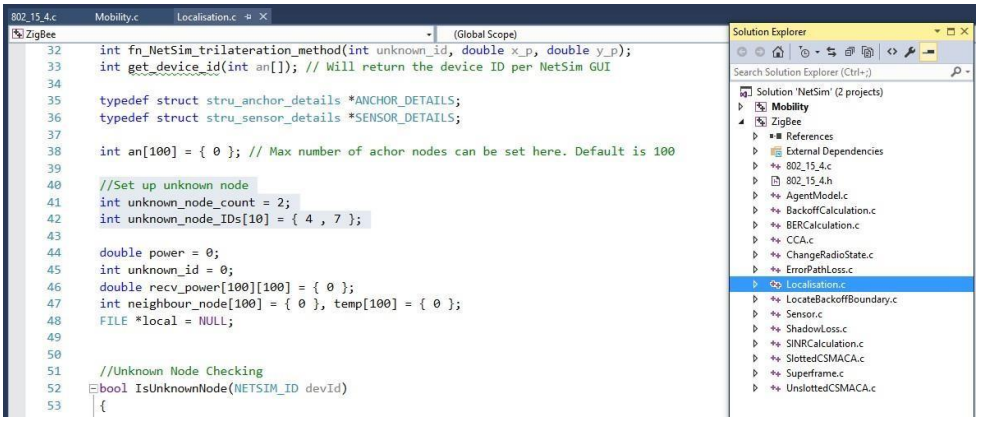


3. Since the unknown nodes are mobile, we have added a call to localization in **fn_NetSim_Mobility_Run()** function present in **mobility.c** file inside Mobility project to calculate the new positions of the unknown node whenever a node moves.

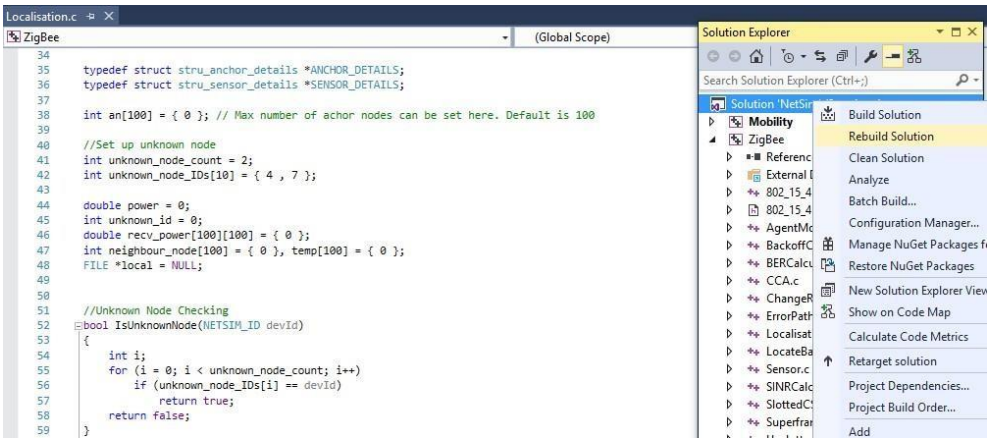


Steps:

- Go to home page, Click on **Open Simulation** ⟶ **Workspace options** ⟶ **Open code**

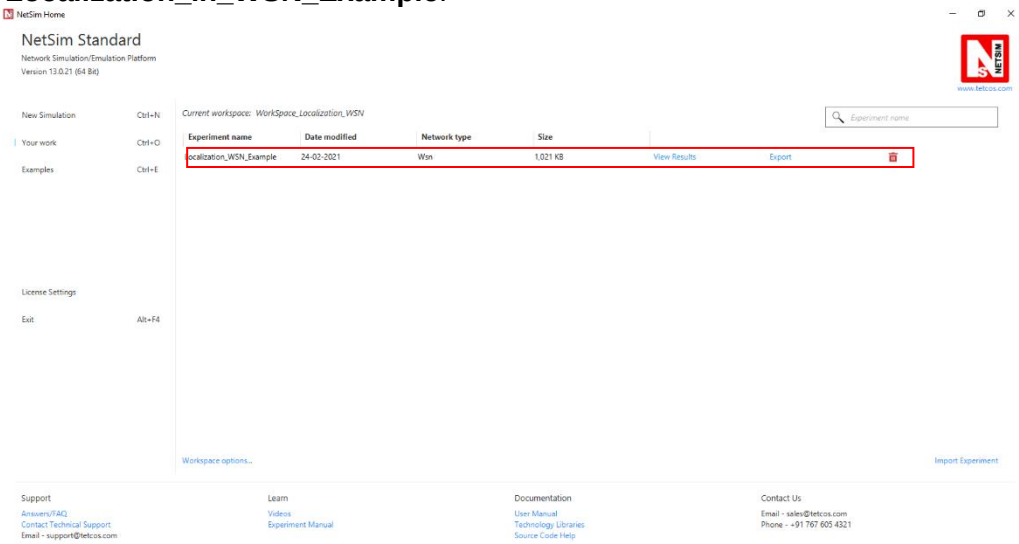


- Right click on Solution in Solution Explorer and select rebuild solution.



- Upon rebuilding, **libZigbee.dll** and **libMobility.dll** will automatically get updated in NetSim binary folder.

- Go to NetSim home page, click on **Open Simulation**, Click on **Localization_in_WSN_Example**.



- Run simulation after the network scenario gets loaded.
- After simulation, localisation.txt file will get created in the **bin** folder of NetSim. Right click on the NetSim shortcut icon in your desktop and select Open file location to go to NetSim bin folder. The localisation.txt file logs the unknown node IDs, received powers from all anchor nodes to unknown nodes, anchor node IDs based on highest received powers and the position or coordinates of the unknown nodes with variation in time as shown below.

```
From 3 to 7 is: -84.7827469788 dbm
From 5 to 7 is: -85.1956026853 dbm
From 6 to 7 is: -87.7656517820 dbm
From 8 to 7 is: -89.4904372973 dbm
From 9 to 7 is: -86.0518999457 dbm
Unknown node = 4
Anchor nodes = 1, 2, 9,
The position of Unknown node 4 at time 24000000.000000µs = 7, 12
Unknown node = 7
Anchor nodes = 1, 2, 3,
The position of Unknown node 7 at time 24000000.000000µs = 62, 9

Unknown nodes
4
7
Received powers
From 1 to 4 is: -80.3528052692 dbm
From 2 to 4 is: -83.1987039075 dbm
From 3 to 4 is: -86.4787581036 dbm
From 5 to 4 is: -87.2647955930 dbm
From 6 to 4 is: -89.2354282518 dbm
From 8 to 4 is: -90.6437199782 dbm
From 9 to 4 is: -86.4472286436 dbm
From 1 to 7 is: -77.8310409707 dbm
From 2 to 7 is: -79.5792536503 dbm
From 3 to 7 is: -84.7827469788 dbm
From 5 to 7 is: -85.1956026853 dbm
From 6 to 7 is: -87.7656517820 dbm
From 8 to 7 is: -89.4904372973 dbm
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```