

5G Channel Model: Pathloss File Input

Software: NetSim Standard v14.0, Visual Studio 2022

Project Download Link:

https://github.com/NetSim-TETCOS/5G-Pathloss-Input-File_v13.3/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>

Features

Using this workspace users can

- Input a pathloss file for each gNB in the network. NetSim would read the pathloss text file for the gNB in the network. This file is used for identifying best server and for calculating signal strength.
- Vary the 5G channel model in NetSim, by modifying the pathloss values in the file.

Example

Consider the example 1 Macro-Cell-gNB and 1UE with fixed mobility

- The **5G-Pathloss-Input-File_v14.0 workspace** comes with a sample configuration that is already saved. To open this example, go to Your Work and click on the **1-Macro-gNB-1UE_fixed** sample from the list of examples.
- The downloaded directory includes a subfolder named "Pathloss-Log-Sample." Within this subfolder, there is a reference text file containing pathloss values specifically associated with a Macro Cell gnb.
- The scenario consists of 1 gNB and 1 UE. An external pathloss file is given as input to the Macro Cell gNB. This will override whatever channel model is set via the GUI.
- Users should pay attention to the Macro Cell gNB's co-ordinates. It is not part of the pathloss file, and is set via the GUI (X, Y co-ordinates). Make sure that the gNB co-ordinates match (or is suitably transformed) the co-ordinates used for generating the pathloss file.
- The network is simulated for 60 s with application generation rate as 38 Mbps.

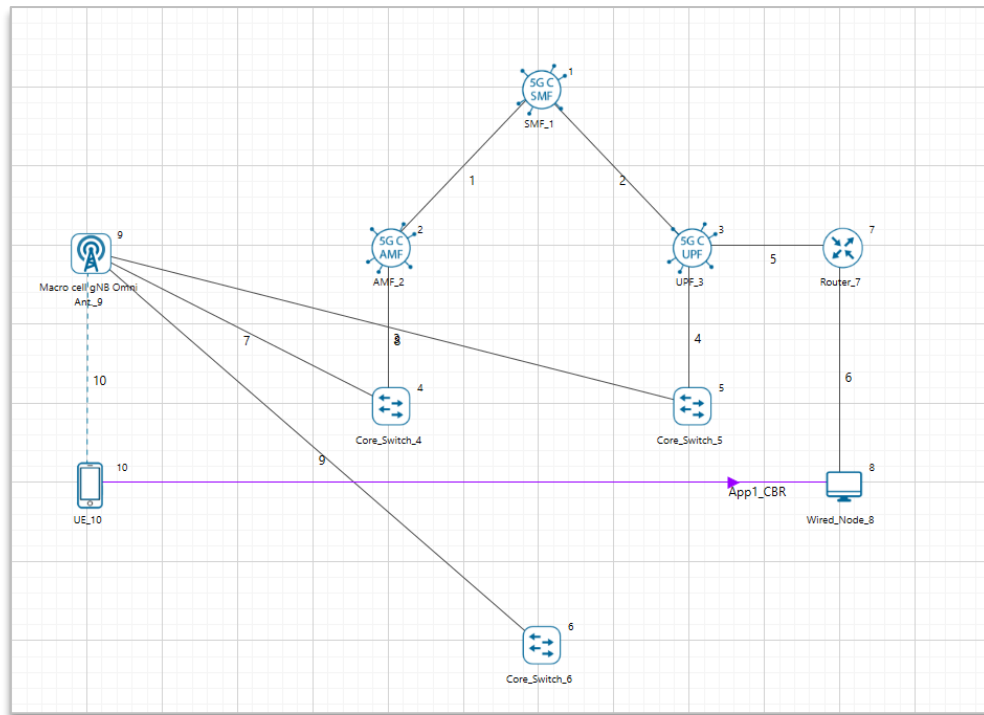


Figure 1: Scenario showing UE downloading data from a server via the 5G Core and the Macro-Cell-gNB

- Upon clicking the RUN button, the log folder path is automatically opened. User should place the files containing the pathloss for gNB in here.

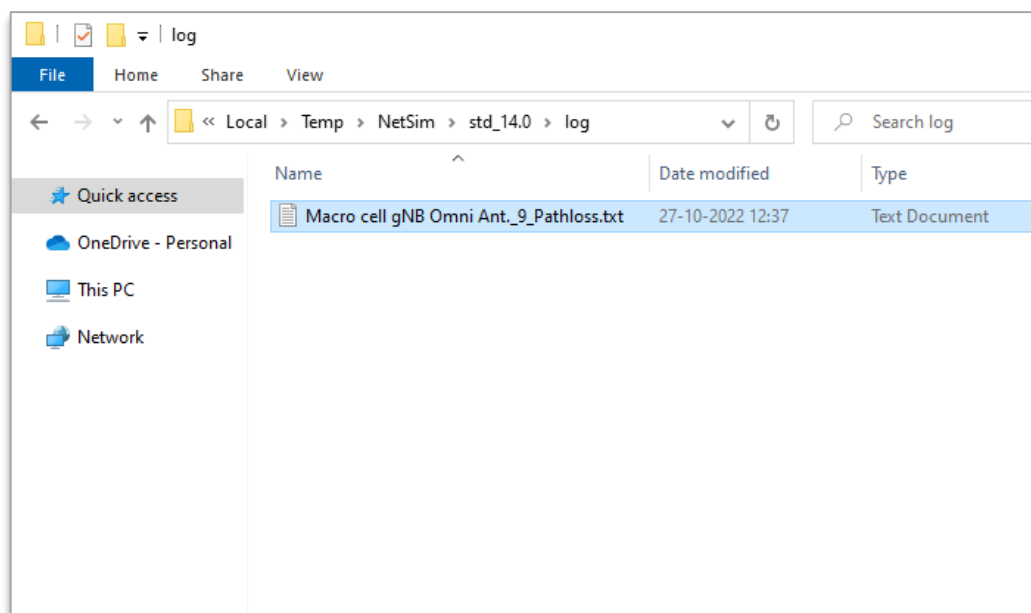


Figure 2: User should place the pathloss file in this log folder

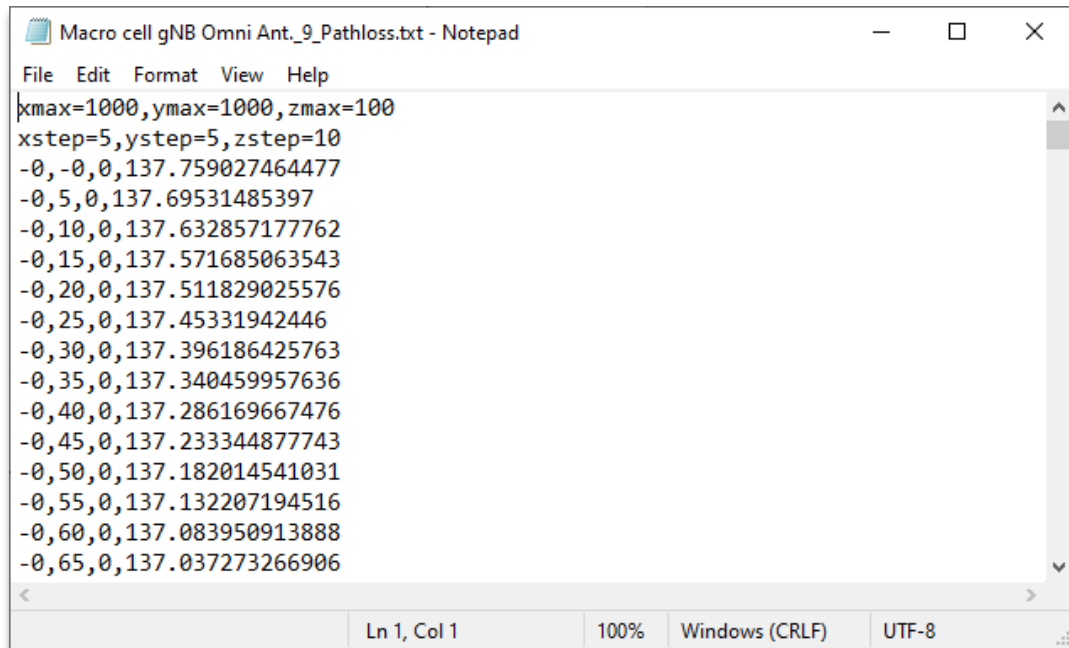
- The pathloss file should start with the device name followed by “_Pathloss” and be saved as a text file (*.txt).
- The pathloss file should be per the given format:
- The first two lines must have the below parameters.

**max=<X-axis length(m)>, ymax=<Y-axis length(m)>, zmax=<Z-axis length(m)>
 xstep=<X-axis step length(m)>, ystep=<Y-axis step length(m)>, zstep=<Z-axis step length(m)>**

Here the axis length is the max distance till which points would be given. The number of entries along X for example will be X-Axis-Length divided by X-Axis-Step-Length.

The pathloss does not change between each point; it only changes at the “next” point whose co-ordinates are determined by the step-length.

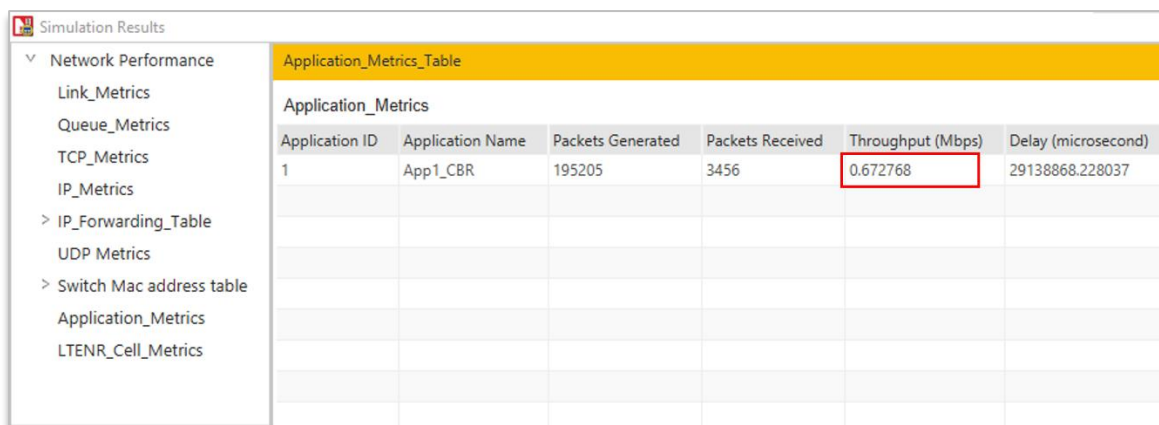
- Subsequently x, y, z coordinates with pathloss value must be given.
x_ co-ordinate (m), y_ co-ordinate (m), z_ co-ordinate (m), pathloss (dB)
- An example screenshot is provided below.



```
Macro cell gNB Omni Ant._9_Pathloss.txt - Notepad
File Edit Format View Help
xmax=1000,ymax=1000,zmax=100
xstep=5,ystep=5,zstep=10
-0,-0,0,137.759027464477
-0,5,0,137.69531485397
-0,10,0,137.632857177762
-0,15,0,137.571685063543
-0,20,0,137.511829025576
-0,25,0,137.45331942446
-0,30,0,137.396186425763
-0,35,0,137.340459957636
-0,40,0,137.286169667476
-0,45,0,137.233344877743
-0,50,0,137.182014541031
-0,55,0,137.132207194516
-0,60,0,137.083950913888
-0,65,0,137.037273266906
Ln 1, Col 1 100% Windows (CRLF) UTF-8
```

Figure 3: Pathloss File format

- Note that if UE is placed at or moves to a location beyond xmax, ymax then the pathloss will be taken as 500 dB.
- If input file is provided for an Macro-cell gNB then pathloss calculations will happen as per that, else NetSim will use the standard pathloss models to calculate the pathloss.
- Once the simulation starts, the command window it will show a Message as “**Close the folder and press any key to continue**”.
- Place your Pathloss input file in the folder opened. Next, close the folder and press any key.
- Simulation starts running.
- Upon completion of simulation the pathloss input provided will have an impact on performance metrics parameters such as the application throughput, that is displayed in the results dashboard.



The screenshot shows the 'Simulation Results' window. On the left is a tree view under 'Network Performance' containing: Link_Metrics, Queue_Metrics, TCP_Metrics, IP_Metrics, IP_Forwarding_Table, UDP Metrics, Switch Mac address table, Application_Metrics, and LTENR_Cell_Metrics. The main area displays the 'Application_Metrics_Table' with a table titled 'Application_Metrics'. The table has columns: Application ID, Application Name, Packets Generated, Packets Received, Throughput (Mbps), and Delay (microsecond). The first row shows data for Application ID 1, Application Name App1_CBR, Packets Generated 195205, Packets Received 3456, Throughput 0.672768 (highlighted with a red box), and Delay 29138868.228037. There are several empty rows below.

Application_Metrics_Table					
Application_Metrics					
Application ID	Application Name	Packets Generated	Packets Received	Throughput (Mbps)	Delay (microsecond)
1	App1_CBR	195205	3456	0.672768	29138868.228037

Figure 4: NetSim results dashboard

Appendix: NetSim source code modifications

Open the source codes in Visual Studio by going to Your Work -> Workspace Options and clicking on the Open Code button.

Changes in LTE_NR.c file function for reading and opening the input pathloss file has been called.

```
static bool isLTENRConfigured = false;
static bool isLTENRTraceConfigured = false;
static bool isCalledOnce = false;
static bool isMetricsCalled = false;
//Function prototype
int fn_NetSim_LTE_NR_Init_F();
int fn_NetSim_LTE_NR_Configure_F(void** var);
int fn_NetSim_LTE_NR_Finish_F();
#pragma endregion

#pragma region LTENR_INIT
_declspec(dllexport) int fn_NetSim_LTE_NR_Init()
{
    if (!isCalledOnce)
    {
        FileBasedPathlossWritingFile();
        FileBasedPathlossReadingFile();
        LTENR_fn_InterferenceInit();
        fn_NetSim_LTENR_HARQ_Init();
        LTENR_RadioMeasurements_Init();
        fn_NetSim_LTE_MAC_PRBLOG();
        fn_NetSim_LTE_TTTLOG();
        isCalledOnce = true;
    }
    return fn_NetSim_LTE_NR_Init_F();
}
```

Changes in LTENR_Propagation_Model.c

```
static double calculate_pathloss_only(ptrLTENR_PROPAGATIONINFO info)
{
    if (pathlossInfo[info->gnbld - 1])
    {
        return fn_netsim_get_pathloss_from_file(info->gnbld, info->ueld);
    }
    double fc = info->frequency_gHz;
    double PL1, PL2, PL3, distance2D, distance3D, distanceBP;
    double pathloss_RMa_LOS = 0, pathloss_RMa_NLOS = 0;
    double pathloss_UMa_LOS = 0, pathloss_UMa_NLOS = 0;
    double pathloss_UMi_LOS = 0, pathloss_UMi_NLOS = 0;
    double pathloss_InH_LOS = 0, pathloss_InH_NLOS = 0;

    double hBS, hUT, W, h;
```

```
double h_effectiveEnv, hBS_effective, hUT_effective;  
  
distance2D = info->dist2D;  
distance3D = info->dist3D;  
  
LTENR_LOS_NLOS_STATE state = info->propagationConfig->state;
```

The ReadPathlossInput.c file contains the following functions:

FileBasedpathlossReadingFile()

Reads the pathloss file given by user and stores the coordinates and pathloss values for each gNB in a separate list.

fn_netsim_get_pathloss_from_file()

Returns the pathloss at a requested receiver coordinate with respect to the transmitter gNB.

FileBasedPathlossWritingFile()

This function is to open the path where user can place the pathloss file for a GNB.