

Channel notching in Cognitive Radio Networks

Software Recommended: NetSim Standard v12.1 (32/64 bit), Visual Studio 2019

In Cognitive Radio networks, the secondary user (CR CPE) actively senses for the presence of the primary user (Incumbent). If the CR_CPE detects the primary user, then UCS Notifications will be sent by the secondary user to the base station. UCS notifications are generated at the end of the quiet period. Upon receiving the UCS notification BS checks for possible interference between Primary and secondary users. If interference is detected, secondary users vacate the channel and will be moved to a different vacant channel if available.

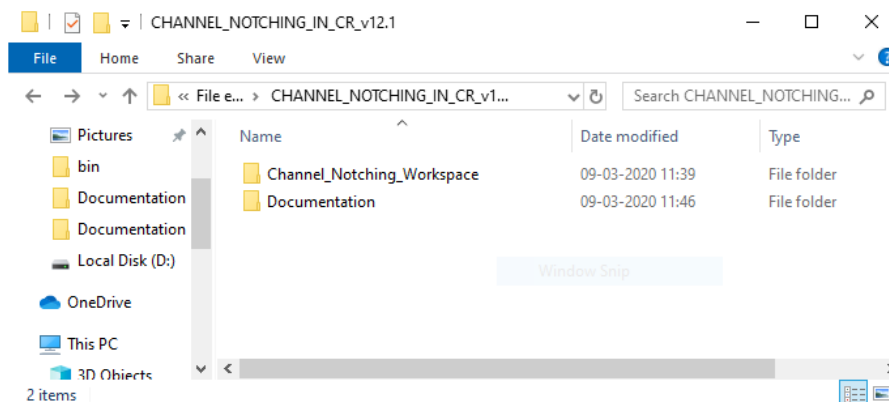
Channel Notching basically allows the primary and secondary users to co-exist in the same channel. This is achieved by allowing the secondary users to use the free sub channels which are not occupied by the primary users, as compared to the standard case (without channel notching), where the entire channel is blocked even if some of the sub channels of that channel are being used by the Incumbent.

Hence, in cases where there are limited available channels, using Channel Notching will help in achieving higher throughput and channel utilization.

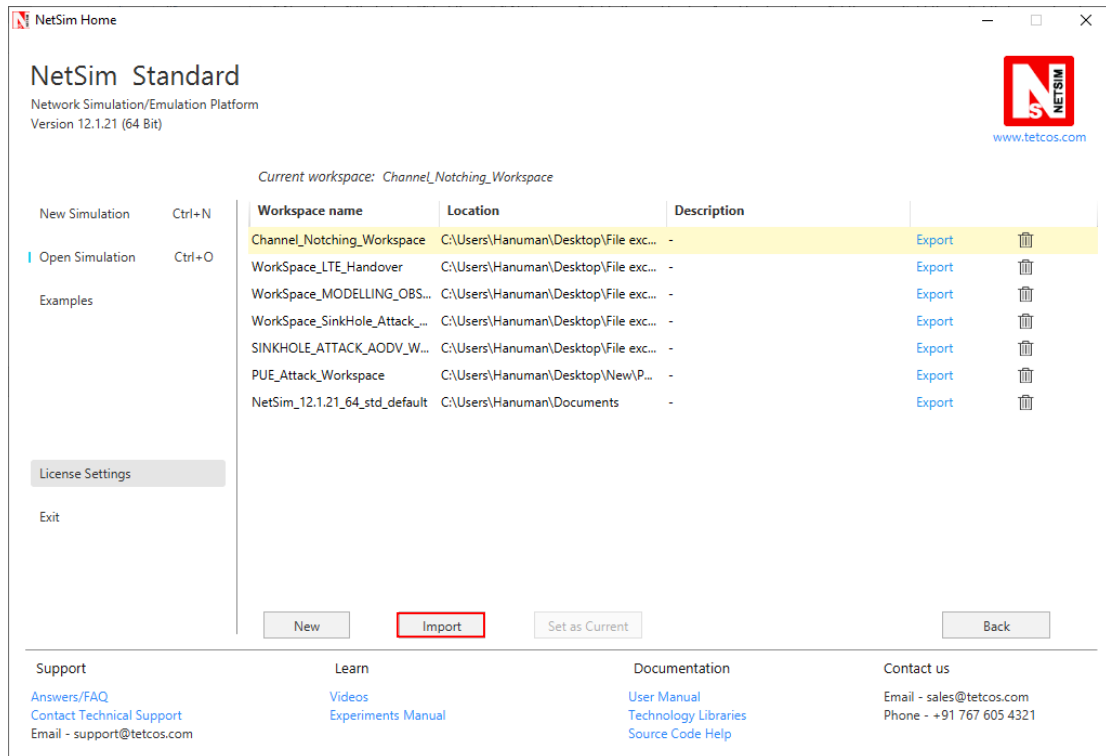
Note: Channel notching code will work only for a single Channel, single CR-CPE and for at-most one Incumbent.

Steps:

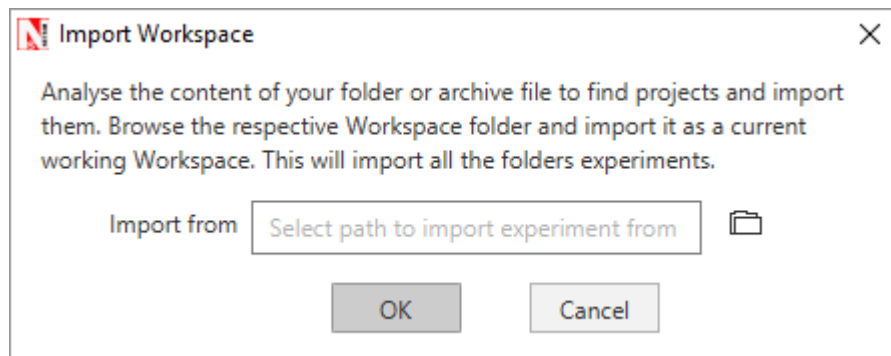
1. The downloaded project folder contains the folders Documentation and Channel Notching Workspace directory as shown below:



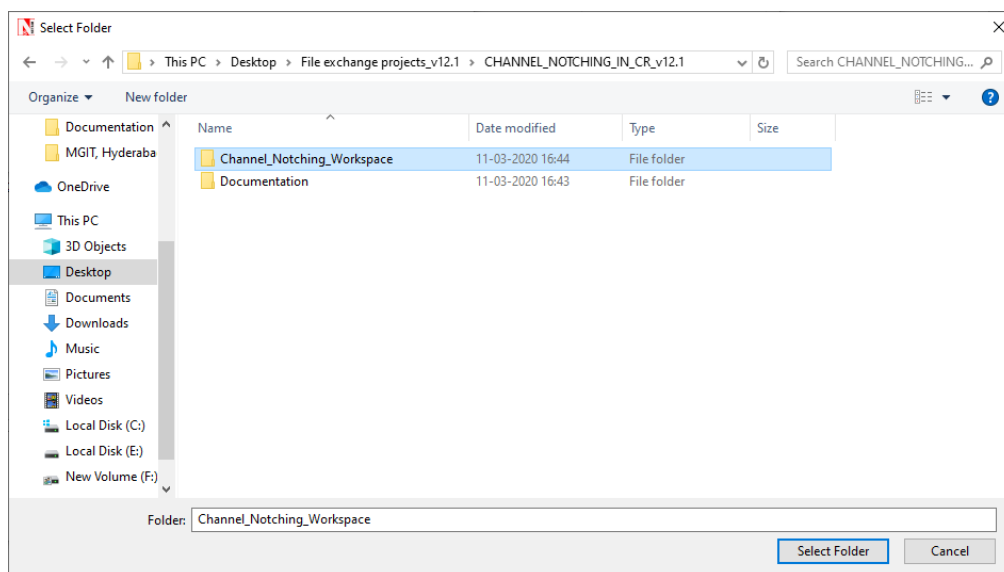
2. Import Channel_Notching_Workspace by going to Open Simulation->Workspace Options->More Options in NetSim Home window. Then select Import as shown below:



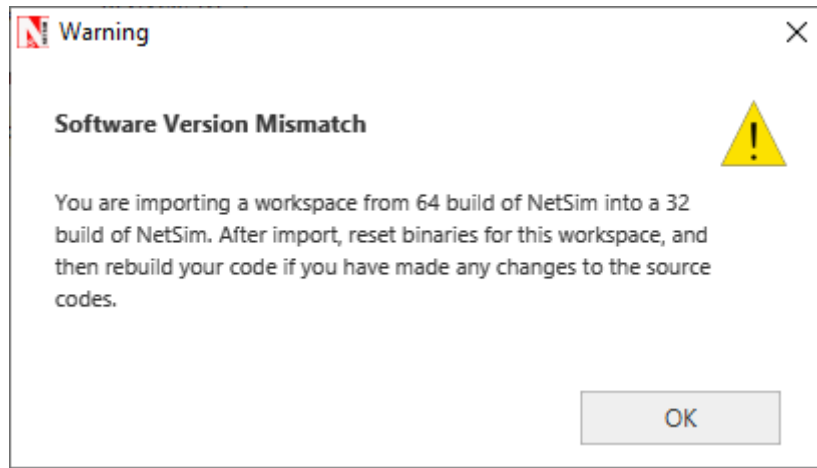
- It displays a window where users need to give the path of the workspace folder and click on OK as shown below:



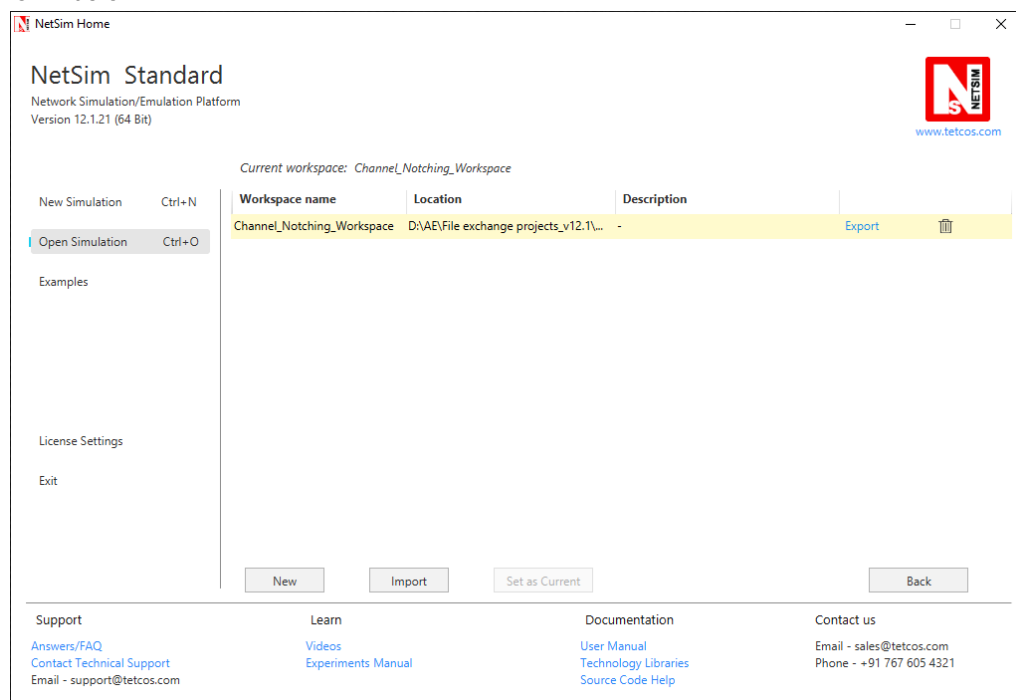
- Browse to the Channel_Notching_Workspace_v12 folder and click on select folder as shown below:



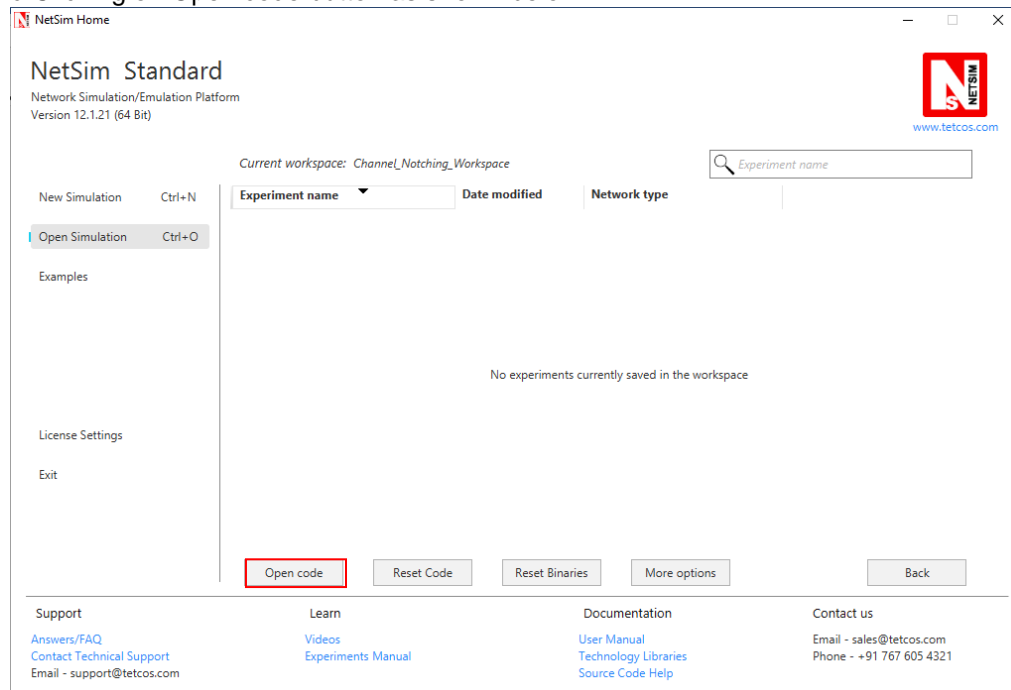
- After this click on OK button in the Import Workspace window.
- While importing the workspace, if the following warning message indicating Software Version Mismatch is displayed, you can ignore it and proceed.



7. The Imported workspace will be set as the current workspace automatically. To see the imported workspace, click on Open Simulation->Workspace Options->More Options as shown below:



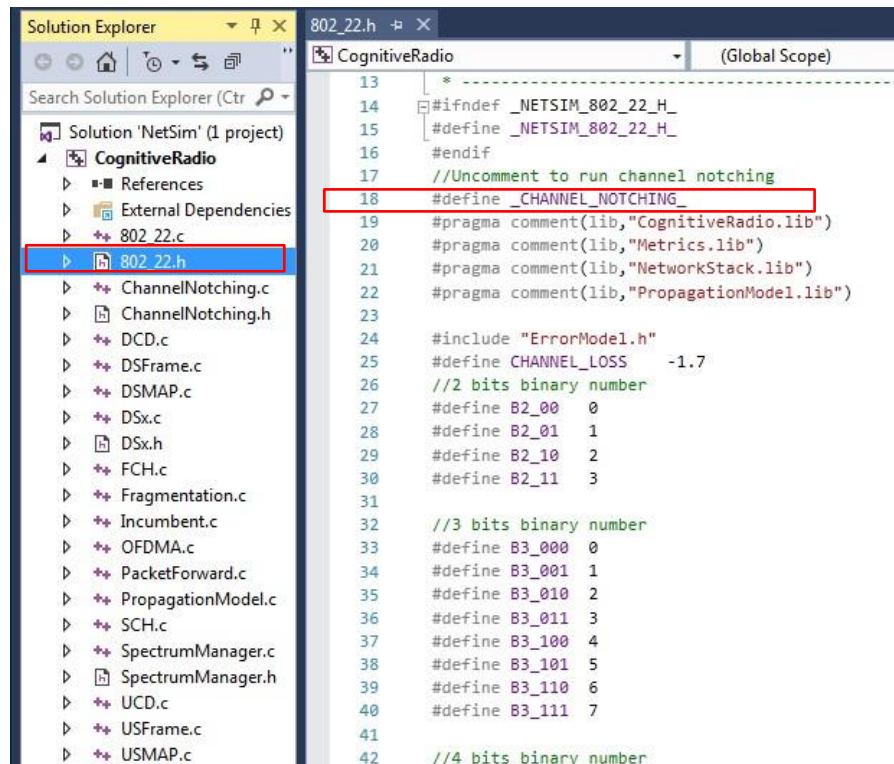
8. Open the Source codes in Visual Studio by going to Open Simulation-> Workspace Options and Clicking on Open code button as shown below:



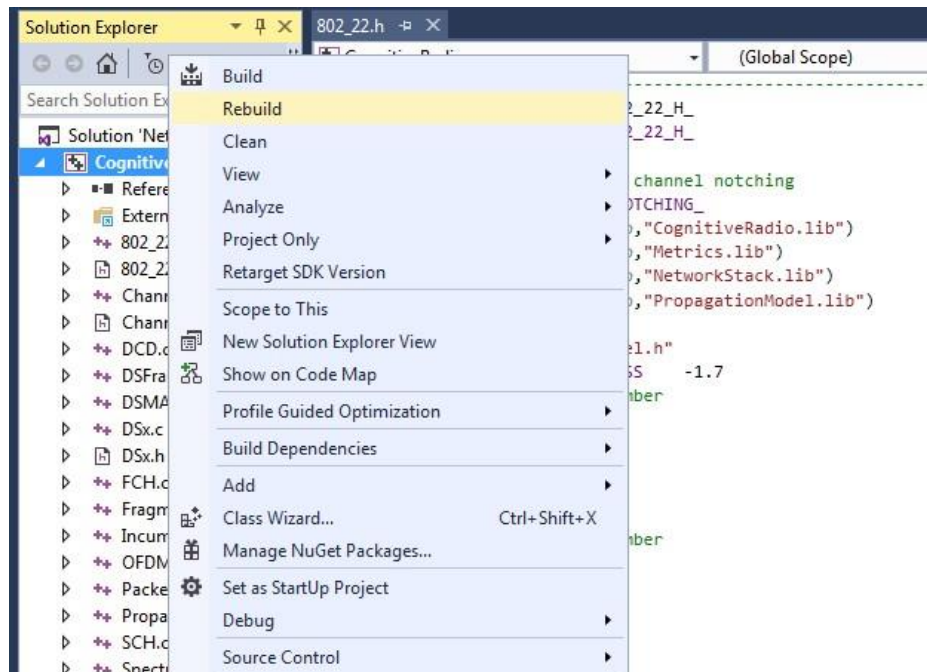
9. In the Solution Explorer, go to **Cognitive Radio > 802_22.h** and open it.

10. If you want to enable **Channel Notching**, uncomment (if commented)

#define _CHANNEL_NOTCHING_



11. Right click on **Solution Explorer-> Rebuild project**



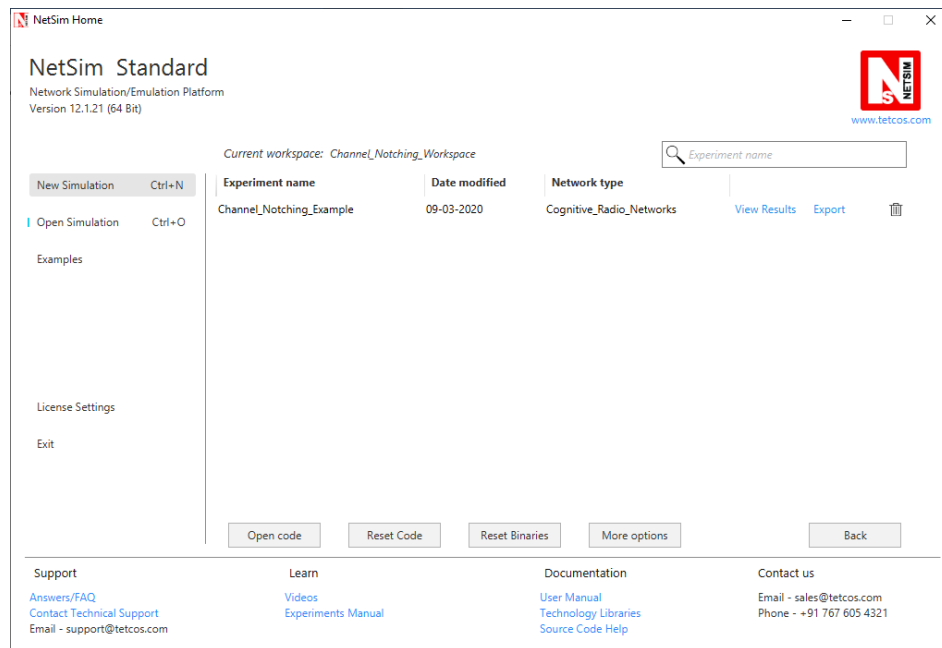
12. You should see a message in the **Output** window as shown in the following figure.

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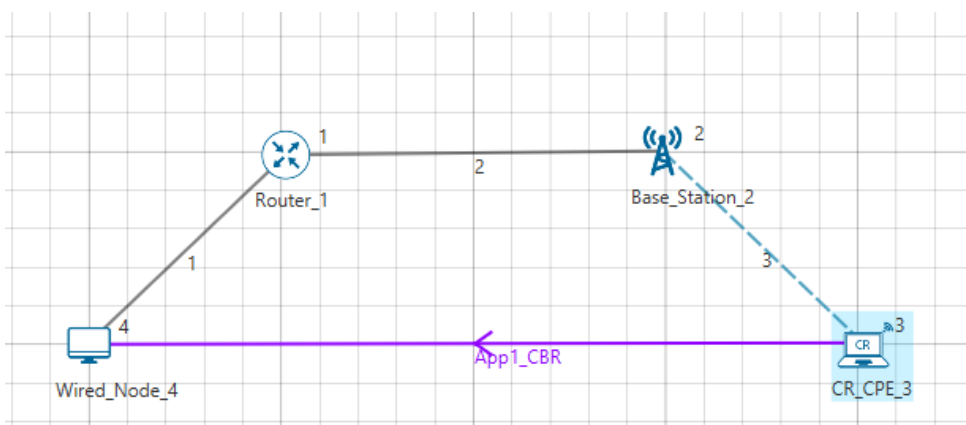
Output
Show output from: Build
1>802_22.obj : warning LNK4075: ignoring '/EDITANDCONTINUE' due to '/OPT:LBR' spec
1> CognitiveRadio.lib(802_22.lib.obj) : MSIL .netmodule or module compiled with /
1>802_22.obj : warning LNK4075: ignoring '/EDITANDCONTINUE' due to '/OPT:LBR' spec
1> Creating library ..\D11\CognitiveRadio.lib and object ..\D11\CognitiveRadio.lib
1>LINK : warning LNK4098: defaultlib 'MSVCRT' conflicts with use of other libs; use /
1> Generating code
1> Finished generating code
1>CognitiveRadio.lib(802_22.lib.obj) : warning LNK4099: PDB 'CognitiveRadioLib.pdb'
1> CognitiveRadio.vcxproj -> D:\Projects_v10\x86\Channel_Notching_in_NetSim_10\Cc
1> CognitiveRadio.vcxproj -> ..\D11\CognitiveRadio.pdb (Full PDB)
===== Rebuild All: 1 succeeded, 0 failed, 0 skipped =====

```

13. Then Channel_Notching_Workspace comes with a sample configuration that is already saved. To open this example, go to Open Simulation and click on the that is present under the list of experiments as shown below:



14. The scenario looks like



15. And set BS properties as

The screenshot shows the 'Cr_Bs' configuration window. On the left, there is a sidebar with three tabs: 'GENERAL', 'INTERFACE_1 (ETHERNET)', and 'INTERFACE_2 (COGNITIVE_RADIO)'. The 'INTERFACE_2 (COGNITIVE_RADIO)' tab is selected. The main area is divided into two sections: 'DATALINK_LAYER' and 'INCUMBENT1'. The 'DATALINK_LAYER' section has the following settings: 'ISO_Country_Code' is 'IND', 'Incumbent count' is '1', and 'Max Incumbent Count' is '1'. The 'INCUMBENT1' section has the following settings: 'Name' is 'Incumbent 1', 'ID' is '1', 'X_Co_Ordinate' is '250', 'Y_Co_Ordinate' is '75', 'Z_Co_Ordinate' is '0', 'Oper_Freq_Start(MHz)' is '55', 'Oper_Freq_End(MHz)' is '56', 'ON_Duration(s)' is '10', 'OFF_Duration(s)' is '0', 'Keepout_Distance(m)' is '500', and 'Oper_Distribution' is 'Constant'. A red rectangle highlights the frequency and duration settings: 'Oper_Freq_Start(MHz)', 'Oper_Freq_End(MHz)', 'ON_Duration(s)', 'OFF_Duration(s)', and 'Keepout_Distance(m)'. At the bottom, there are 'OK' and 'Reset' buttons.

DATALINK_LAYER	
ISO_Country_Code	IND
Incumbent count	1
Max Incumbent Count	1

INCUMBENT1	
Name	Incumbent 1
ID	1
X_Co_Ordinate	250
Y_Co_Ordinate	75
Z_Co_Ordinate	0
Oper_Freq_Start(MHz)	55
Oper_Freq_End(MHz)	56
ON_Duration(s)	10
OFF_Duration(s)	0
Keepout_Distance(m)	500
Oper_Distribution	Constant

16. Run the scenario for both the cases: with channel notching and without it. The throughputs obtained will be **0.002949** and **0.000000** respectively