Channel notching in Cognitive Radio Networks

Software Recommended: NetSim Standard v12.0 (32/64 bit), Visual Studio 2019

Follow the instructions specified in the following link to clone/download the project folder from GitHub using Visual Studio: <a href="https://tetcos.freshdesk.com/support/solutions/articles/14000099351-how-to-clone-netsim-file-exchange-project-repositories-from-github-exchange-pro

Other tools such as GitHub Desktop, SVN Client, Sourcetree, Git from the command line, or any client you like to clone the Git repository.

Note: It is recommended not to download the project as an archive (compressed zip) to avoid incompatibility while importing workspaces into NetSim.

Secure URL for the GitHub repository:

https://github.com/NetSim-TETCOS/Channel_Notching_in_CR_Networks_v12.0.git

Introduction:

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:

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2. Import Channel_Notching_Workspace_v12 by going to Open Simulation->Workspace Options->More Options in NetSim Home window. Then select Import as shown below:

		Current workspace: Channel_	Notching_Workspace		
New Simulation	Ctrl+N	Workspace name	Location	Description	
	010	Channel_Notching_Workspac	F:\Vishal - NetSim\Channel_Notch	n	Export 🔟
Open Simulation	Ctrl+O	NetSim_12.0.18_64_pro_default	C:\Users\NetSim\Documents	NetSim Default Workspace	Export 🔟
Examples					
License Settings					
		Neur	Set as Connect		D = -1
		INEW	port Set as current		DdCK
Support		Learn	I	Documentation	Contact us
Answers/FAQ		Videos	-U T	ser Manual	Email - sales@tetcos.com
Email - support@tetcos	s.com	Experiments Manu	an i S	ource Code Help	Phone - +91 707 003 4321

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

🚺 Import Workspace		×
Analyse the content them. Browse the re working Workspace	of your folder or archive file to find projects and import spective Workspace folder and import it as a current This will import all the folders experiments.	
Import from	Select path to import experiment from	
	OK Cancel	

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

N Select Folder			×
\leftarrow \rightarrow \checkmark \uparrow \blacksquare « Vi	sh > Channel_Notching_in_CR_Ne	✓ ♂ Search Channel	Notching_in P
Organize 🔻 New fold	er		:== - ?
This PC	Name	Date modified	Туре
3D Objects		15-10-2019 15:56	File folder
Desktop		15-10-2019 11:57	File folder
Documents			
Downloads			
Music			
Pictures			
Videos			
Sindows 10 (C:)			
Installation files			
Gffice (E:)			
F: (F:)			
•			
Folde	er: Channel_Notching_Workspace_v12		
		Select Folder	Cancel

- 5. After this click on OK button in the Import Workspace window.
- **6.** 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:

		Current workspace: Channel	Notching_Workspace		
New Simulation	Ctrl+N	Workspace name	Location	Description	
		Channel_Notching_Workspac	F:\Vishal - NetSim\Channel_Notc	hin	Export 🔟
Open Simulation	Ctrl+O	NetSim_12.0.18_64_pro_default	C:\Users\NetSim\Documents	NetSim Default Workspace	Export III
Examples					
Licence Settings					
ciccinse settings					
		New Im	Set as Current		Back
Support		Learn		Documentation	Contact us
Answers/FAQ		Videos		User Manual	Email - sales@tetcos.com
Contact Technical Sup Email - support@tetco	port is.com	Experiments Manu	al	Technology Libraries Source Code Help	Phone - +91 767 605 4321

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

		Current workspace: Channel_Notchin	ng_Workspace_v12		C Experim	nent name		
New Simulation	Ctrl+N	Experiment name	Date modified	Network type				
Open Simulation	Ctrl+O	Channel_Notching_Example	15-10-2019	Cognitive_Radio_Netw	vorks	View Results	Export	Ŵ
Examples								
License Settings								
		Open code Reset Co	de Reset Bina	ries More optic	ons		Back	
Support		Learn		Documentation		Contact	us	
Answers/FAQ Contact Technical Sup Email - support@tetc	oport os.com	Videos Experiments Manual		User Manual Technology Libraries Source Code Help		Email - sa Phone - +	iles@tetcos.com ⊦91 767 605 432	:1

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

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

#define _CHANNEL_NOTCHING_

Solution Explorer $~$ $=$ \square \times	802_22.h ⇒ ×
© ⊂ ∰ ™ © - ≒ ₫ ″	🔁 CognitiveRadio 🗸 (Global Scope)
Search Solution Explorer (Ctr. 9 -	
	14#1+ndet _NEISIM_802_22_H_
Solution 'NetSim' (1 project)	15 [#define_NEISIM_802_22_H_
🔺 🏝 CognitiveRadio	16 #enalt
References	17 //oncomment to run channel hotching
External Dependencies	19 #pragma_comment(lib."CognitiveBadio.lib")
▶ ++ 802_22.c	20 #pragma comment(lib, "Metrics.lib")
▶ 🖪 802_22.h	21 #pragma comment(lib,"NetworkStack.lib")
++ ChannelNotching.c	<pre>22 #pragma comment(lib,"PropagationModel.lib")</pre>
ChannelNotching.h	23
++ DCD.c	24 #include "ErrorModel.h"
++ DSFrame.c	25 #define CHANNEL_LOSS -1.7
t+ DSMAP.c	26 //2 bits binary number
> ++ DSx.c	27 #define B2_00 0
▶ 🕞 DSx.h	28 #define B2_01 1
b the FCH c	29 #define B2_10 2
b the Fragmentation c	30 #define B2_11 3
> the Incumbent c	31
> ++ OEDMA -	32 //3 bits binary number
THE OPDIVIA.C	35 #define B3 001 1
P T+ PacketForward.c	35 #define B3 010 2
P ++ PropagationModel.c	36 #define B3 011 3
P ++ SCH.c	37 #define B3 100 4
++ SpectrumManager.c	38 #define B3 101 5
SpectrumManager.h	39 #define B3 110 6
++ UCD.c	40 #define B3_111 7
++ USFrame.c	41
Image: State St	42 //4 bits binary number

11. Right click on Cognitive Radio project→ Rebuild

Solutio	n Explorer		<mark>▼ </mark>	
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⊳	802_2		Retarget SDK Version	,"NetworkStack.lib")
Þ	++ Chanr		Scope to This	,"PropagationModel.lib")
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Ď	++ Packe	Ф	Set as StartUp Project	
Þ	++ Propa		Debug	
⊳	++ SCH.c		Source Control	
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12. You should see a message in the **Output** window as shown in the following figure.

Output	$\bullet \square \times$
Show output from: Build	2
<pre>1>802_22.obj : warning LNK4075: ignoring '/EDITANDCONTINUE' due to '/OPT:LBR' 1> CognitiveRadio.lib(802_22_lib.obj) : MSIL .netmodule or module compiled w 1>802_22.obj : warning LNK4075: ignoring '/EDITANDCONTINUE' due to '/OPT:LBR' 1> Creating library\Dll\CognitiveRadio.lib and object\Dll\Cognitive 1>LINK : warning LNK4088: defaultlib 'MSVCRT' conflicts with use of other lit 1> Generating code</pre>	spec with / spec Radic os; us
1> Finished generating code 1>CognitiveRadio.lib(802 22 lib.obj) : warning LNK4099: PDB 'CognitiveRadioLib's and the second s	b.pdt
<pre>1> CognitiveRadio.vcxproj -> D:\Projects_v10\x86\Channel_Notching_in_NetSim_ 1> CognitiveRadio.vcxproj ->\Dll\CognitiveRadio.pdb (Full PDB)</pre>	_10\Cc
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4	

13. Then Channel_Notching_Workspace_v12 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:

		Current workspace: Channel_No	tching_Workspace_v12	Q EX	periment name	
New Simulation	Ctrl+N	Experiment name	Date modified	Network type		
Open Simulation	Ctrl+O	Channel_Notching_Example	15-10-2019	Cognitive_Radio_Networks	View Results Export	Ē
Examples						
icense Settings						
		Workspace options			Import Experi	iment
upport		Learn		Documentation	Contact us	
nswers/FAQ ontact Technical Sup	port	Videos Experiments Manual		User Manual Technology Libraries	Email - sales@tetcos.co Phone - +91 767 605 43	m 321

14. The scenario looks like



15. And set BS properties as	
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Cr_Bs		— 🗆 X	
Cr Bs	V DATALINK_LAYER		
-	ISO_Country_Code	IND	
GENERAL	Incumbent count	1 •	
INTERFACE_1 (ETHERNET)	Max Incumbent Count	1	
INTERFACE_2 (COGNITIVE_RADIO)	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 👻	
	► PHYSICAL_LAYER		
	ОК	Reset	

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