Tutorial II: Cadence Virtuoso

ECE6133: Physical Design Automation of VLSI Systems Georgia Institute of Technology Prof. Sung Kyu Lim

Last Updated: 2/7/2022

I. Setup for Cadence Virtuoso

- Copy the following files into your working directory cds.lib display.drf lib.defs .cdsinit (Make sure that the file name is ".cdsinit". If you copy this file from a windows machine, the file name will be "cdsinit".) calibreDRC.rul myDesign.tar.gz You will also need the "test.gds2" file you generated during Innovus lab.
- 2. Type the following commands to source the designated files source /tools/software/cadence/ic/cshrc.latest source /tools/mentor/calibre/aoi2019/meta137.cshrc
- Open cds.lib and replace 'your_working_directory' by your working directory as follows. Type the FULL directory name. You can get it by cd in 'your_working_directory' and typing pwd in the console. Leave "myDesign" untouched at the end. DEFINE myDesign /your working directory/myDesign
- Open lib.defs and replace 'your_working_directory' by your working directory as follows. Same as above: type the FULL directory name. Leave "myDesign" untouched at the end. DEFINE myDesign /your_working_directory/myDesign
- Uncompress myDesign.tar.gz in your working directory. tar -xzf myDesign.tar.gz

6. Run Cadence Virtuoso by typing 'virtuoso'. Make sure to run the command in the same directory as of the .cdsinit file.

II. Generation of Final Layouts

After you have typed 'virtuoso', the Virtuoso window will appear as follows.



a. Choose 'File' -> 'Import' -> 'Stream...', then 'Virtuoso(R) XStream In' window will appear as follows.

Stream File	(required)	
Library	(required)	
Top Cell		
View	layout	
Template File		
	Stream In to Virtual Memory	
Technology		
Generate Technol	ogy Information	
Layer Map		P
Object Map		
Log File	strmin.log	

- 2. Change the file type to "All Files(*)" and choose GDS2 file in 'Stream File' (test.gds2 from Innovus lab)
- 3. Choose myDesign in 'Library'
- 4. The top cell is "test" by virtuoso (this is the name we specified in Innovus when saving test.gds2)
- 5. The window should look as follows

	XStream In	
Stream File	./test.gds2	P
Library	myDesign	
Top Cell	test	
View	layout	
Template File		۵ (۵
	Import to Virtual Memory	
Technology		
 Technology Generate Techno 	logy Information	
 Technology Generate Techno Layer Map 	logy Information	6
 Technology Generate Techno Layer Map Object Map 	logy Information	

6. Click 'Translate'. There must not be any error during translation. If you meet warning messages, you can just click 'No'. (you should have only 1 warning, no error)

Stream in translation complete	×
INFO (XSTRM-234): Translation completed. '0' error(s) and '1' warn D o you wish to view the log file ? Yes	<mark>ing(s)</mark> found.

7. Choose 'Tools' -> 'Library Manager...' in Virtuoso main window which will open the Library Manager window as follows.

<u>File Edit View D</u> esign Manager <u>H</u> elp	cādence
Show Categories Show Files Library US_8ths analub analub analub asvTech bask cdberTechLb functional myDesgn rfLib	View y v v the v v v v v v v v v v v v v v v v v v v
Messages DB was auto refreshed. Log file is "/nethome/spentapati3/ECE6133/test/tmp/libManager.log".	

- 8. Choose 'myDesign' in Library column.
- 9. Choose your design in Cell column ("test")
- 10. Double-click 'layout' in View column.

Implexity Imple	orary		Cell		View	
be myDesign be letest VIS,8hs andigLb andigLb contactCut dcont ndcont ndcont nmos_thkox nmos_thkox nmos_tkox mos_tkox mos_tk		S	7	S	7	
US_8ths XNOR2X1 AhdILb XOR2X1 AhdILb ContactCut dont dont basic Itsist cdsDefTechLib ndcont nmos_thkox nmos_vtil mos_vtil poont pdcont pdcont pdcont pdcont pdcont pdcont pmos_thkox pmos_thkox	myDesign	•	₿ _t ictest	-	ो layout	
X0R2X1 X0mm Import analgLib contarCut dcont import xortech dcont dcont import xoatc itexa itexa import yrepeinon ndoont import import yrepeinon ndoont import import ftsamples nmos_vth import import ftbl nmos_vth import import pdcont pmos_thox pmos_thox pmos_thox	S_8ths		XNOR2X1		View 🛆 Lock	Size
inalogLib contarCtut wTech dcont saic Itest dsDeTechLib ndcont inctional nds_ttag mpOesign nmos_ttag TilneLib pcont pdont pdont pros_ttag pros_ttag pros_ttag pros_ttag	hdlLib		XOR2X1		layout	
WTech dcont saic itest dsDefTechLib ndcont nmos_thiox nmos_thiox mpdeign nmos_tkg nmos_tkg nmos_tkg pros_tkg pros_tkg pros_tkg pros_tkg	nalogLib		contactCut			
asic idds ndcont ndcont unctional nmos_thkox nmos_tkg nmos_tkg ntions_tkg pdcont pdcont pmos_tkg pmos_tkg pmos_tkg	vTech		dcont			
dsdbeftexhlib ndcont undtopal nmos_thiox myOekgn nmos_twg tExamples nmos_twg thub nmos_twg tflineLib pcont pdcont pcont pros_thiox pmos_thiox pros_thiox pros_thiox	asic		ictest			
file nmos_thkox mmos_thg nmos_thg nmos_thg nmos_thg file nmos_thg file nmos_thg file pcont pdcont pcont pmos_thkox pmos_thg pmos_thg pmos_thg	dsDefTechLib		ndcont			
WDesign nmos_vtg fExamples nmos_vth tub nmos_vtl fTlineLib pcont pdcont pmos_thkox pmos_tkox pmos_tkox	unctional		nmos_thkox			
fbamples nmos_vth fbb nmos_vtl flineLib pcont pdcont pcos_thox pmos_thox pmos_vtg	nyDesign		nmos_vtg			
fLlb nmos_vdl fTineLib pcont pdcont pmos_thkox pmos_vg pmos_vg	Examples		nmos_vth			
rffineLib pcont pdcont pmos_thkox pmos_tvg	Lib		nmos_vtl			
pdcont pmos_thox pmos_vtg	TlineLib		pcont			
pmos_thkox pmos_vtg emot_th			pdcont			
pmos.vg			pmos_thkox			
process with			pmos_vtg			
huo2an			pmos_vth			
			via1Cut			

11. You may get messages regarding the unavailability of license. Just click on "Session" every time.



12. Then a layout window will appear. Maximize and zoom-to-fit (by pressing 'f' on keyboard) to get a better clarity.

															1	Virtuo	so® L	ayout Suite	L Editi	ing: myD	esign ic	test lay	out														×
Launch Fi	e <u>E</u> di	t <u>V</u> iew <u>C</u> r	eate Ver	ify Cor	nectivi	ty Optio	ons <u>T</u> ools	Wind	ow Ass	iura Qi	antus	Calibre	Help																							cāde	ence
	10	0 4	0		R		8 🕑	»	19	» I	5 »	Classic			1																						
	-	+ 36	Q-1 4	101	33	>> (F)	Select:0 S	el(N):0	Sel(1):0	Sel(O):0	X 1.60	000	Y 13.6000	dX		dY		Dist: Crnd:																			
Palette	-	7 8 ×		and the									1																								
Layers	_	8 ×																																			
Y All Layers																		1.44		Sin Pr																	
Valid	Jsed]	Routing																	0.0			<u> </u> .															•
L45 draw	ing																		1.1	-																	
AV . NV	• A	5 • NS •																	- il	م ما م		11		+ 4	- 4												
Layer	Pu.	VSA																111	1	1 1 11	• a •	90.0		1 1													
L45	drw	¥ ¥																100.0				1.	and and	T de la	f. il												
metal6	drw P1	**																	1010 0																		
metal6	P2	* *																ه ال ه		2.8 0			10.00														
L63	P1	* *											Bever			_			للبلج	in the				الكه													
pwell	net	¥ ¥											NEGEL.											- 1-	T												
nwell	drw	¥ ¥ U														14		40 - 1	e 114	T let			1.0 110	114													
L51	dow	× ×											PATTERN			-		فيتتع إردا		•	1	n h i s	THE P														
L39	dry	¥ ¥	•										F_INPUT							N I		0 0 0	11		- Pil.				;	-							•
L31	dry	* *																n d a jal		+++	H1.	La h							-teo	LAD							
L02	drw	× ×											POLL						-1.1		1000	1	11 1		(<u> </u>				+ 100	4851							
L33	dnv	¥ ¥															4	1111				<u>1.8</u>	14 111	THE .	101			_	ten	LADA							
L49	drw	¥ ¥															19				r . D			() 	<u> </u>												
L61	drw	¥ ¥	· ·														9.8	4 9 T	9	<u>.</u>		0 0			0			· · ·	= EB	-2161							
L32	drw	× ×											100-0161				1	191. 29		기내 아니	والم يتقدي	• • •	6.0)lr+	ela.				1.ED	B061							
L30	drw	3 3											1.60_0(5)									11/1		NPS.	9 9	-			- LED	_B(2)							
L38	drw	¥ ¥	· ·														-4		4t-			11.1		1-1-1-1					LED.								
vtg	drw	¥ ¥															h.6		197	1 2 1 2	1 1 1	17.			0 10 91	1.			LED	_B(3)							
vtb	drw	÷ -																• •	de t	<u>i bi alli i</u>				i ere i					teo	_B(Ø)							
vth	net	* *	1																-14-	-																	
active	drw	× ×																		1.145	THIN T	1															
nimplant	drw	¥ ¥	Ľ																	1	1																
Dimplant	drw	~ ~ □																																			
Objects		8 ×																																			
Objec	ts.	VS	· ·																																		
- Pins		2 2																				-			+												
- Vias		22																			1111																
Objects C	irids			•	·	•	• •	•	•	•	•	•	• •	• •				• •	•	•	• •	•		•	•	٠	•		•	•	•	•		•	•		
mouse L: m	ouseSi	gleSelectPt()	l														M: h	iZoomAbsolut	eScale(hid	GetCurrent	Window()	0.9)													R: _lxHil	MouseP	opUp()
(2) >													M: h	ZoomAbso	oluteSca	le(hiGet	Curren	tWindow() 0.9)																		0	.md: 📗

- 13. The current window shows standard cells and routed metals but you cannot see the details of standard cells. These abstract cells are called standard cell instances. To get a final layout, we need to load standard cells and replace standard cell instances by standard cell layouts. This is called 'flattening'.
 - a. To do this, choose 'Edit' -> 'Select' -> 'Select All'
 - b. Then choose 'Edit' -> 'Hierarchy' -> 'Flatten...' and click 'OK' in 'Flatten' window with the default settings. Clicking the empty space in design will cancel the selection.

Launch B	ie <u>B</u> dit	Yiew Gree	ste Verity	Cognectiv	ty Options	jods y	Yndow As	syra Opti <u>m</u>	ylae Calilgo	e <u>H</u> elp																		cādenc
00	10	€ 8	0	*	0 15	100	* Q	» Po	> Class	ic.		G.																
P. 15	-	- 66 0	44	01.85	». 071501	ect.0 Seith	Q.0 Seld).0	-Sel(0):0 X	-11.9000	¥ 59.9000	dX.	ar	Dat	Crnd.														
Palette	-	78×			-			-	-		-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Layers		ð×																										
Y Ali Layer										Sec.	The second					HE REAL												
Y Valid	Jest _	Routing									1 1 1	No tali		the T	110102		ng Parti											
135 mm	ing :									EL IN	비니분	김 문주			1 8-4				Tresson State									
AV - NV	* AS	* N5 *								ht.				Sand Par			The state		ESCH									
Layer	Pu.	V 5											444															
1,35	drw	XX												IN COM			A			Fig.4								
1.50	drw	* *										Se white	11 1	n and		THE .			-									
1.47	drw	* *								1888	IL THE			(promotion of the local data is a second se		Lukas e	and the last	the star	A STATE OF	THE J								
1.68	drw	* *								1.4	all all						144		18 1 Jul	in the								
L 89	drw	XX									er a l			A				3 1										
L52	drw	* *										if has	油白色		1000	i haa	ALC: NO.		Distants (int									
1.73	drw	* *								10.000					TO MAN					Y 10 '								
L104	drw	* *								et a		5. H	H Red	# 1. K	L BAR	and state		High H										
L 94	drw	* *									et al la second	12			위 노란 취				i iel	- et -								
1.60	drw.	* *									A \$12(21)	the same	Res 10		The second		ALC: NAME		理一官争	PPI								
L71	drw	* *								The second	6. P. B.	C III					Second and the party			ELE								
L92	drw	* *									313	a shirt a s		学业教育会						1.1.								
pwell	drw	* *								THE OWNER	2020		1. (198)							FILE								
metal6	P1	* *													IR HA	新新社	11. 1 8 (相關的										
metal6	P2 P1	2 2								C.C.C.L	ARAE	(LINE) T	and the		a interes				Contraction of the									
1.63	drw	* *								1							H. N F		The state of the state of the									
pwell	net	* *								1			l a louil	It could be			计控制	山州總。		+++								
nwell	net	* *								100				1000			March 1		1216									
L51	@w	* *									-	有料式		is her	100 11-	tion of the	in he	有相当										
1.39	drw	× ×								1104	<u>n</u> 2					STATISTICS OF												
L62	drw	* *									Sea 11		Sel 2 P			P FL				3425								
1,41	drw	* *								「「「「「「「」」	RIN I	1.04	111			1144	1											
Objects	_	6 ×									I STORE IN	-		The state			以是 能加重	D B	Stall H									
Clife	ts	VS								THE REAL	-		a teat		4742	N. S. Lui												
- Pins	N - 1	XX									IN FIGURE AND			KA. del				In dra water										
Vias	1	* *														Contraction of the local distance	area calla											
Cbjects (irids											8.																

14. Choose 'File' -> 'Save' to save your flattened design.

15. Compare this layout with your encounter layout. Do those look similar?

16. **To Capture Screenshots:** Choose 'File' -> 'Export Image...' in the layout editor. Supported formats are bmp, jpg, png, and so on.

17. How to View Specific Metal Layers and Via:

- a. On the left of your screen, there is 'Layers' tab. In here you can control visibility of each layers.
 - i. If you click 'NV', only the selected layer will be shown
 - ii. If you click 'AV', all layers will be shown
 - iii. Check the 'Used' box in the Layers section to only show the important layers and vias. Then uncheck or check the corresponding visibility box 'V' to un-toggle or toggle the visibility of a given layer.

P	alette		? 🗗 🗙
L	.ayers		ð X
Y	All Layers		_
~	Valid 🗹 U	lsed 📃 Ro	outing
Filt	er Q Filt	er	-
	L39 drawi	ng	
A	V 🔻 NV		NS 🔻
^	Layer	Purpo	V S
	pwell	drw	v v
	nwell	drw	~ ~
	a ctive	drw	v v
Ê.	nimplant	drw	v v
e,	pimplant	drw	v v
	poly	drw	 ✓
\boxtimes	contact	drw	 ✓
88	metal1	drw	 ✓
***	via1	drw	 ✓
	metal2	drw	
***	via2	drw	 ✓
\square	metal3	drw	
***	via3	drw	 ✓
	metal4	drw	 ✓
	metal5	drw	
	metal6	drw	
\square	metal7	drw	 ✓
	metal8	drw	 ✓
	metal9	drw	 ✓
<u>.</u>	metal10	drw	

- iv. After you toggle visibilities, you can re-draw the layout to apply the changed visibilities. (Choose 'View' -> 'Redraw', or click 'Zoom to Fit' button in the toolbar)
- v. Choose 'Tools' -> 'Display Resource Manager' in the main Virtuoso window. When 'Display Resource Tool Box' appears, click Edit, and Display Resource Editor window appears. Choose any metal layer, change 'Fill Color' and 'Outline Color', and click 'Apply'. Redraw the layout to see if the new color was applied well.

Vi	irtuoso® 6.1.7-6	4b - Log: /nethome/spentapati3/CDS.log	×
<u>File T</u> ools <u>O</u> ptions <u>H</u> elp			cādence
Loading hsm.cxt Loading ncl.cxt *INFO* (icLic-302) License Virt Loading layers.cxt	uoso_Layout_Suite_	_GXL ("95321") was used to run Layout L.	
mouse L: mouseSingleSelectPt()	M: techM	lanagerOpenDisplayToolBox(0:560 nil)	R: _JxHiMousePopUp()
Display Resources T	ool Box ×		
File <u>H</u> elp	cādence		
Edit	Merge		
5 HelpAction		1	

cāden					le <u>H</u> elp
	e packet attributes	Packet: y1 Change fill style for r	-		vice display
Fill Sty	Line Style	Outline Color			Valid LPPs
			vDesign		
					5-555
	_ () (1		Select LPP
			•		Q Search
			Pac	Purpose	Layer
			annot	drawing	L104
	.		y4	drawing	L30
			y6	drawing	L31
		A second s	у3	drawing	L32
			y9	drawing	L33
-			y1	drawing	L35
Current:			y5	drawing	L36
			y1	drawing	L37
			y6	drawing	L38
Lucion.	1 N		y5	drawing	L39
Modified			y8	drawing	L41
			y2	drawing	L45
)		y4 🔄	drawing	L47
	Custom	Custom			

- b. Here is the metal layer mapping. You will need this in 'Lab Problem: Generation of final layouts and DRC' section.
 - i. L49 metal 1
 - ii. L51 metal 2
 - iii. L62 metal 3
 - iv. L31 metal 4
 - v. L33 metal 5
 - vi. L37 metal 6
 - vii. L39 metal 7
 - viii. L41 metal 8
 - ix. L43 metal 9
 - x. L45 metal 10
- c. Actually each metal layer has two different names. For example, metal 1 layer has two names 'metal 1' and 'L49'

III. Design Rule Checking (DRC)

 After flattening, choose 'Calibre' -> 'Run nmDRC'. Click 'Cancel' in 'Load Runset File' window. The caliber window would then appear (there might be some defaults filled in)

	Calibre Interactive - nmDRC v2021.4_33.16	×
<u>File</u> <u>T</u> ranscript	Setup	Explore New Calibre Interactive Help
Rules	DRC Rules File	
Inputs		View Load
Outputs		
Run <u>C</u> ontrol	Check Selection Recipe: Checks selected in the rules file	Edit
Tr <u>a</u> nscript	DRC Run Directory	
Run <u>D</u> RC		
Start R <u>V</u> E	- 🕂 Layer Derivations	

2. For the DRC rules file, select the button with three dots (...) and then select the calibreDRC.rul file. Just check if the "Rules" button on the left turns green. The final window would be like this:

	Calibre Interactive - nmDRC v202	1.4_33.16 ×
<u>F</u> ile <u>T</u> ranscript	Setup	Explore New Calibre Interactive Help
Rules	DRC Rules File	
Inputs	l ↓ calibreDRC.rul	View Load
Outputs		
Run <u>C</u> ontrol	Check Selection Recipe: Checks selected in the rules file	Edit
Tr <u>a</u> nscript	DDC Dur Directory	
· ·		
Run <u>D</u> RC		
Start RVE	- + Layer Derivations	

- 3. DRC Run Directory should already be auto-filled with your current directory. You can leave this as it is. If this is empty, enter your current full directory path in this box
- 4. Click 'Inputs' tab. The window would be auto-filled as follows:

Elle Transcript Setup Bules Inputs Queputs Queputs Queputs Format: CDSII Transcript Bun Control Transcript Bun DRC Format: CDSII Top Cell: test Ubrary Name: max Area:		Ca	libre Interactive - nmDRC v2021.4_33.16	×
Bules Run: DRC (Hierarchica) _ Recon Recon Inverse Analyze	<u>F</u> ile <u>T</u> ranscript	Setup	Explore New Calibre Interactive	<u>H</u> elp
Qutputs Layout Waivers Run QRC Format: GDSII Start RVE Library Name: myDesign View Name: layout I	<u>R</u> ules	Run: DRC (Hierarchical) — R	econ 🗆 Recon Inverse 🗖 Analyze	
Run Control Format: GDSII © Export from layout viewer Image: Control Run DRC Top Cell: test Image: Control Image: Control Image: Control Start RVE Library Name: myDesign Image: Control Image: Control	Outputs	Layout Waivers		
Transcript Run DRC Top Cell: test Start RVE Library Name: iayout Area:	Run <u>C</u> ontrol	Format: GDSII -	Export from layout viewer	*
Run DRC Top Cell: test Start RVE Library Name: myDesign View Name: fayout	Tr <u>a</u> nscript	Layout File: test.calibre.db		
Start RVE Library Name: myDesign View Name: layout Area:	Run <u>D</u> RC	Top Cell: test		
View Name: layout	Start RVE	Library Name: myDesign		
Area:		View Name: layout		
		T Area:		

- 5. Run DRC by clicking 'Run DRC' button
- 6. When DRC is finished, look at the following window to check the number of DRC violations



- 7. A check box will be red if it has any DRC violation.
- 8. Summary of DRC would be stored in *.drc.results and *.drc.summary in your working directory.