Introduction to Cadence

Dr Basel Halak

Learning Outcomes



After completing this unit, you should be able to:

- **1. Set up a directory to run Cadence**
- 2. Install the design files for the AMS 0.35um PDK
- 3. Run the Cadence Design Manager (ICFB)
- 4. Create a Cadence Project
- 5. Create a simple Cadence Cell View (Schematic)
- 6. Link to an external library in Cadence
- 7. Use the external blocks in your design

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Introduction

- The first thing we need to do is to create a directory that has the correct setup and config files to run:
 - A: Cadence
 - B: the AMS PDK (Process Design Kit)
- Log onto a Unix Machine (hind) using NX Client or Exceed
 - See instructions on:
 - <u>http://users.ecs.soton.ac.uk/bim/notes/cad/guides/begin.</u>
 <u>html</u>

Create a new directory in your home directory

• /home/username/EDA/lab1

Set up the current working directory

- The first step is to set up the local working directory for the AMS 0.35µm process.
- open a new terminal and type the following: tcsh
 - source /opt/esdcad/scripts/ams_v400_tcshrc

Run Cadence Design Manager

This will bring up the Cadence Design Manager:

| Č | Virtuoso® 6.1.6-64b - Log: /home/tz1g12/CDS.log.1 | |
|---|---|---------|
| <u>F</u> ile <u>T</u> ools <u>O</u> pti | ons <u>H</u> elp | cādence |
| Program: Hierarchy: Sub version: Working Directo | <pre>@(#)&CDS: virtuoso version 6.1.6-64b 05/03/2013 14:44 (sjfnl178) & /home/esdcad/software/cadence/linux/IC6.16.005/tools.lnx86/dfII/ sub-version IC6.1.6-64b.101 (64-bit addresses) ry: hind.ecs.soton.ac.uk:/home/tz1g12/6097/zty_demo_new_cadence</pre> | |
| COPYRIGHT © 199 © 199 | 2-2013 CADENCE DESIGN SYSTEMS INC. ALL RIGHTS RESERVED. 2-2013 UNIX SYSTEMS Laboratories INC., Reproduced with permission. | |
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- 7. Use the external blocks in your design

Create a new library

Cadence works by creating multiple libraries in separate directories

Using the Tools Menu – select the library manager

| Library Mana | ger: Directory1g12/6097/zty_dem | o_new_cadence | |
|---|---------------------------------|---------------|-------------|
| <u>F</u> ile <u>E</u> dit <u>V</u> iew <u>D</u> esign Manager <u>H</u> | lp | | cādence |
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| Log file is "/home/tz1g12/6097/zty_den | o_new_cadence/libManager.log". | | |
| | | Lib, Library | Eroo: 2 257 |

The Library manager handles "libraries", "cells" and "views"

| | Library Manager | Directory | 1g12/6097/ | zty_demo_ | new_cadenc | e | |
|---|-------------------------------------|---------------|-----------------|-----------|------------|--------------|---------------|
| <u>F</u> ile <u>E</u> dit <u>V</u> iew <u>E</u> | <u>)</u> esign Manager <u>H</u> elp | | | | | | cādence |
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Libraries are the containers for all the design elements. For example a sandard cell library may contain all the gates available in the PDK

| Library | Annager: Directory1g12/6097/zty_demo_new_cadence | _ 🗆 🗙 |
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| avTech basic | ty_demo_new_cadence/libManager.log". | |
| | | |
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Each element, such as a gate, in the library is called a cell – an example might be an inverter gate.

| Library Manager: | Directory1g12/6097/zty_demo | _new_cadence | | - Cell | |
|--|---|---|---|---|--|
| <u>F</u> ile <u>E</u> dit ⊻iew <u>D</u> esign Manager <u>H</u> elp | | | cādence | INVO | |
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| Messages | w_cadence/libManager.log". | | | JK1 JK3 JKC1 | |
| | 101 | | | JKC3 JKCP1 | |

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Finally, each cell has a set of different views such as schematic, or layout, or a model

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|---|-------------------------------|-------------------------|----------|-----------|------|
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| IOLIBC_3B_4M | IMUX32 | layout msps | 21k Syll | 100 | IJK |
| IOLIBC_ANA_3B_4M | IMUX33 | symbol | 19k | | |
| IOLIB_3B_4M | IMUX41 | | | | |
| IOLIB_4M | IMUX42 | | | | |
| IOLIB_ANA_4M | INV1 | | | | |
| LEADFRAMES | INV2 INV3 | | | | |
| PACKAGES | INV4 | | | | |
| PRIMLIB | INV6 INV8 | | | | |
| SPIRALS_4M | INV10 | | | | |
| TECH_C35B3 | INV12 | | | | |
| US_8ths | JK1 | | | | |
| ahdlLib appled ib | JK3 | | | | |
| avTech | JKC3 | | | | |
| basic | JKCP1 | | | | |
| Messages | | | | | |
| Log file is "/home/tz1g12/6097/zty_demo_n | ew_cadence/libManager.log". | | | | |
| | | | | | |
| | | | | | |
| | | Lib: CORELIB Free: 379. | 07G / | | |

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Libraries in Cadence

The library definition in Cadence consists of two parts:

- 1. The library NAME what you see in the library manager
- 2. The library DIRECTORY what is actually there in the file system

DO NOT just copy the library around, as this does not handle all the links properly.

Create your first library

To create new libraries, you can use the library manager (LM) to create a new library from scratch

| | Libr | ary Man | ager: | Director | |
|----|---|---------|-------------------|------------------|--|
| Ei | le <u>E</u> dit <u>V</u> iew <u>D</u> esign I | Manager | <u>H</u> elp | | |
| | <u>N</u> ew | • | <u>L</u> ib | irary | |
| 2 | 7 <u>O</u> pen | Ctrl+O | <u>C</u> e | II View | |
| | Open (<u>R</u> ead-Only) | Ctrl+R | C <u>a</u> tegory | | |
| R | Open Wit <u>h</u> | | | INV0 | |
| - | Load Defaults | | \wedge | IMUX23 IMHX24 | |
| | <u>S</u> ave Defaults | | | IMUX30 | |
| - | Open Shell Window | Ctrl+P | | IMUX31 IMUX32 | |
| | Exit | Ctrl+X | | IMUX33 IMUX40 | |

Create your first library

The library manager will default to your current directory, and ask you for a library name:

- enter *library1* or something similar
- remember:
 - Follow UNIX rules
 - Don't use spaces
 - Don't start with a number

| | New Library | |
|---|---|---------|
| ibrary Name Library1 Directory | il2/6097/zty_demo_new_cadence/ gcfConstraints.gcf inverter_for_layout.dnv inverter_for_layout.log inverter_for_layout.rsf inverter_for_layout.vtr inverter_for_layout.vtr inverter_layout_02.sp libManager.log libManager.log libManager.log libManager.log.cdslck like_amsic61_tcsh pearl.cmd pace13.314 cmd | |
| cds.lib compare.rul ile type: Directorin esign Manager Use NONE | 28 | |
| Use No DM | | |
| | | |

Creating your first library

- When you create a library, you will be asked whether you want to attach to a technology file
- What does this mean?
- When you create a design, you are working with either NO process, or a SPECIFIC process (this implies a certain number of layers, design rules, models etc)
- In this case we are working with the AMS C35B4C3 process.

Creating your first library

Choose "attach to an existing techfile"

| Technology File for New Library |
|--|
| Technology File for library "Library2" |
| You can: 🕥 Compile an ASCII technology file |
| Reference existing technology libraries |
| Attach to an existing technology library |
| Do not need process information |
| OK Cancel Help |

And choose TECH_C35B4

| C Attach Li | brary to Technology Library 🛛 🗙 |
|--------------------|--|
| New Library | Library2 |
| Technology Library | LEADFRAMES TECH_C35B3 TECH_C35B4 US_8ths analogLib avTech |
| | OK Cancel Apply Help |

Creating your first library

Congratulations!, You will now have your first Cadence Library

Creating your first cell view

- Now you have your first library, you can create your first cell view.
- Start from the library manager and choose New Cell View.



Creating a cell view

- Notice the library defaults to the one you have just created
- If you don't have this selected, make sure that it is the standard libraries will be READ ONLY
- Notice the View Name schematic
- The Tool pulldown should be Schematics XL





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Creating a cell view

When you create a new cell view, the Cadence Design manager will open the correct editing tool – in this case Schematic L (schematic editor)

automatically

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Adding Components

- You can now add components to the schematic
- To add components (transistors, passives, sources etc) you must use the Create -> Instance option



- Whenever you add an instance you need to use the same library structure (library, cell, view) idea as when you created your own cells.
- You need to use the symbol view
- Luckily, Composer allows you to Browse for the correct cell using the library manager

| | Add Instance | |
|----------|--|---------|
| Library | Direct | (a a u |
| Cell | BIUN | wse j |
| View | symbol | ~ |
| Names | | |
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| Array | Rows 1 Columns 1 | |
| 4 | 🖹 Rotate 🛛 🕼 Sideways 🛛 🚭 Upside Down | |
| | Hide Cancel Defaults Help | |



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Don't forget to check and save your schematic

Once you have saved the schematic, you can close it using File -> Close



- Cadence provide a simple library of electronic primitives such as voltage sources, resistors, capacitors etc
- These can be constructed into circuits and simulated, however they do not have the information to be physically fabricated

We can use them to build a simple test circuit to learn how the design software works

Create a simple RC circuit



Add a pulse voltage source

AnalogLib->vsource

- Source type: pulse
- DC voltage=1
- Zero value: 0
- One Value: 1
- Period of waveform:20ns
- Pulse width: 10ns
- Rise time: 100ps
- Fall time: 100ps

| Apply To Only curre | ent 🔽 instance 🔽 | |
|-------------------------------|-------------------------------|-----------|
| Show 📃 system | 🗹 user 🗹 CDF | |
| Browse | Reset Instance Labels Display | |
| Property | Value | Display |
| Library Name | analogLib | off 🔽 |
| Cell Name | vsource | off 🔽 |
| View Name | symbol | off 🔽 |
| Instance Name | Ψ0 | off 🔽 |
| | Add) Delete) Modif | y) |
| User Property | Master Value Local Valu | e Display |
| Ivsignore | TRUE | off 🔽 |
| CDF Parameter | Value | Display |
| DC voltage | 1 1 | off 🔽 |
| Source type | pulse 🔽 | off 🔽 |
| Frequency name 1 | | off 🔽 |
| Delay time | 0 s | off 🔽 |
| Type of rising & falling edge | | off 🔽 |
| Zero value | 0 4 | off 🔽 |
| One value | 1 V | off 🔽 |
| Period of waveform | 20n s | off 🔽 |
| Rise time | 100p s | off 🔽 |
| Fall time | 100p s | off 🔽 |
| Pulse width | 10n s | off 🔽 |
| Display small signal params | | off 🔽 |
| Display temperature params | | off 🔽 |
| Display noise parameters | | off 🔽 |
| Multiplier | | off 🔽 |

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Reference to ground

AnalogLib -> gnd

No parameters

| | Add Instance | × |
|---------|---------------------------------------|---|
| Library | analogLib Browse | |
| Cell | gnd | |
| View | symbol | |
| Names | | |
| 🗹 Add W | ire Stubs at: O all terminals | |
| Array | Rows 1 Columns 1 | |
| | 🖺 Rotate 🛛 🚺 Sideways 🛛 🚭 Upside Down | |

Connects globally to ground

Add resistors, inductor & capacitor

AnalogLib->res

- resistance = 1 for series
- resistance = 1k for load

AnalogLib->cap

• capacitance = 1n

Connect up

Use Create -> Wire(narrow)

• this gives a connect function – wire up the circuit

Add wire names

- Create -> Wire Name
- Label the input vin and the output vout

Check and Save

Click on Launch – ADE L

| 🏁 | ADE L (3) - Library2 inverter schematic | |
|--|---|--------------------|
| Launch <u>F</u> ile <u>E</u> dit <u>V</u> iew <u>C</u> reate Chec <u>k</u> (| Launch Session Setup <u>A</u> nalyses <u>V</u> ariables <u>O</u> utputs <u>S</u> imulation <u>R</u> esults <u>T</u> ools <u>H</u> elp | cādence |
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| ADE GXL | Design Variables Type Enable Arguments | ODC OTrans |
| Layout XL | Name Value | 95 |
| Layout <u>G</u> XL | | } ⊕→ |
| Layout EAD | | H-m-+ |
| Schematics L | | * |
| Schematics XL | | |
| Create Madel (SMC) | Outputs | ? 8 × 🕥 |
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Click on Analyses Tab and choose tran analysis and set Stop Time: 100ns as shown below

| 48 | ADE L (3) | - Library2 inverter so | hematic | | | ı 🗙 | | | |
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| | | | | | 🔾 psp | 🔾 qpss | 🔾 qpac | 🔾 qpnoise | |
| | | | | | 🔾 qpxf | 🔾 qpsp | 🔾 hb | 🔾 hbac | |
| | | | | | 🔘 hbnoise | | | | |
| | | Outputs | | | Т | Fransient A | Analysis | | |
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Select output to be plotted by clicking on:

Outputs Tab - To be Plotted – Select on Schematic

Then choose the wires: in and out in the schematic window

| ibr | ary2 inverter sch | 1ematic |
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Than click Netlist and Run Tap to simulate

| ADE L (3 | 3) - Library2 inverter schematic | |
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| 9(11) Netlist and Run | Status: Selecting outputs to be plotted T=27 C Simu | ulator: spectre |

You should be able to see the simulation results



You can now close the simulation window and the schematic view of your cell

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re-opening the schematic

- From the library manager, find your schematic cell view
- Right Click on the selected cell view
- Choose the "Open" option

Composer will open your schematic for editing

Learning Outcomes



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How does Cadence Know about Libraries?

- Cadence uses a file called cds.lib to establish the libraries
- It looks first in the current working directory, then your home directory for this
- It also has a default cds.lib if none exists

- This is an ASCII file that has the library name and actual location
- environmental variables are often used in these path definitions to make them general and portable

- It is good practice to set up your working directories with custom design kit settings AND libraries
- Keeping projects separate makes administration and management of files MUCH easier.
- Therefore, each project directory should have its own cds.lib

How can I reference someone else's design?

- Given that the definition of a library is done using a name and pathname, can we use this to reference other libraries not in our design space?
 - Yes, but remember that the technology MUST be compatible
 - This is how the design kits work we simply reference the libraries in the design kit location
 - You may also not have edit rights perhaps read only
- You need to know, therefore:
 - The library NAME
 - The library LOCATION

An example

- There is an examples library which has the name library_lab1
- It is in the location /home/bh9/lab1/library_lab1

How can we link to that existing library?

- First load up the library manager and select :
 - Edit->Library Path

Edit Library Path

Type in the library name you need

- Then type in the absolute path name to the directory, including the library name itself
- Close the editor and save the cds.lib file

| - | r://zty_demo_new_cadence/cds.llb [NameSpace CDBA] (Not l | Locke _ |
|---|--|---------|
| <u>F</u> ile <u>E</u> dit <u>V</u> iew <u>D</u> esign | Manager <u>H</u> elp | cāden |
| Libraries | | |
| Library | Path | |
| analogLib | \$CDSDIR/tools/dfll/etc/cdslib/artist/analogLib | |
| 2 functional | \$CDSDIR/tools/dfll/etc/cdslib/artist/functional | |
| basic | \$CDSDIR/tools/dfll/etc/cdslib/basic | |
| US_8ths | \$CDSDIR/tools/dfll/etc/cdslib/sheets/US_8ths | |
| ahdlLib | \$CDSDIR/tools/dfll/samples/artist/ahdlLib | |
| i bmslib | \$CDSDIR/tools/dfll/samples/artist/bmslib | |
| TECH_C35B3 | \$AMS_DIR/cds/HK_C35/TECH_C35B3 | |
| PRIMLIB | \$AMS_DIR/cds/HK_C35/PRIMLIB | |
| IOLIB_4M | \$AMS_DIR/cds/HK_C35/IOLIB_4M | |
| 0 IOLIBV5_4M | \$AMS_DIR/cds/HK_C35/IOLIBV5_4M | |
| 1 IOLIB_ANA_4M | \$AMS_DIR/cds/HK_C35/IOLIB_ANA_4M | |
| 2 CORELIB | \$AMS_DIR/cds/HK_C35/CORELIB | |
| 3 GATES | \$AMS_DIR/cds/HK_C35/GATES | |
| 4 GATES_3B | \$AMS_DIR/cds/HK_C35/GATES_3B | |
| 5 sbaLib | \$CDSDIR/tools/dfll/etc/cdslib/artist/sbaLib | |
| 6 LEADFRAMES | \$AMS_DIR/cds/HK_ALL/LEADFRAMES | |
| 7 A_CELLS | \$AMS_DIR/cds/HK_C35/A_CELLS | |
| 8 PACKAGES | \$AMS_DIR/cds/HK_ALL/PACKAGES | |
| 9 PRIMLIBRF | \$AMS_DIR/cds/HK_C35/PRIMLIBRF | |
| 0 CORELIB_3B | \$AMS_DIR/cds/HK_C35/CORELIB_3B | |
| 1 IOLIB_ANA_3B_4M | \$AMS_DIR/cds/HK_C35/IOLIB_ANA_3B_4M | |
| 2 IOLIBC_3B_4M | \$AMS_DIR/cds/HK_C35/IOLIBC_3B_4M | |
| 3 IOLIBC_ANA_3B_4M | \$AMS_DIR/cds/HK_C35/IOLIBC_ANA_3B_4M | |
| 4 BORDERS | \$AMS_DIR/cds/HK_ALL/BORDERS | |
| 5 TECH_C35B4 | \$AMS_DIR/cds/HK_C35/TECH_C35B4 | |
| 6 IOLIB_3B_4M | \$AMS_DIR/cds/HK_C35/IOLIB_3B_4M | |
| 7 SPIRALS_4M | \$AMS_DIR/cds/HK_C35/SPIRALS_4M | |
| 8 avTech | /home/esdcad/software/cadence/linux/assura410/tools/assura/etc/avtech/avTech | |
| 9 Library1 | /home/tz1g12/6097/zty_demo_new_cadence/Library1 | |
| 0 Library2 | /home/tz1g12/6097/zty_demo_new_cadence/Library2 | |
| h lib1 | /home/tz1g12/6097/zty_demo_new_cadence/lib1 | |
| 2 library_lab1 🔶 | /home/bh9/lab1/library_lab1 | |
| 2 Libroru3 | /home/tz1g12/6097/zty_demo_new_cadence/Library3 | |
| 10 cibraryo | | |

New Library....



Summary

- You can now create and edit your own libraries
- You can see how to link and share other directories into your Cadence library manager
- In the library_lab1 library you will find a basic RC circuit

