EE 330 Laboratory 1
Cadence Virtuoso Platform Setup

Fall 2023

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Background Information

The laboratory experiments in this course are a critical component in learning about integrated electronics. For some topics material will first be introduced in the lecture part of the course with follow-up in the laboratory and for some topics material will be first introduced in the laboratory with supporting formulations coming in subsequent lectures. Regardless, a good tightly-coupled CAD environment is an essential part of the process of designing integrated electronic circuits today. In the laboratory, you will be asked to design circuits, observe the effects of different design parameters on circuit performance, and draw conclusions from collected data. Unlike in other labs, such as those in EE 201 or EE 230, you will generally not be given explicit instructions on what to measure or do, and you will certainly not be given a lab report template to fill out. Instead, especially as the semester progresses, you will be challenged to complete a general task and then be expected to figure out how to achieve that task on your own. Of course, For example, you may be asked to "design a small-signal amplifier with a gain of 5 given that V_{DD} and V_{SS} are $10V$ and $0V$, respectively." On that note, do not become frustrated if you struggle with some of labs or if your designs do not work on the first try; Most of the learning that occurs in the EE 330 labs is not from the specific results, but from the process of obtaining those results.

This laboratory experiments will make extensive use of the Virtuoso platform, which is Cadence's toolset for IC design, simulation, layout, and validation. Cadence Virtuoso, a commercial-grade platform, is one of the most widely used toolsets available in the IC design industry and is extremely powerful. There is a significant learning curve associated with the productive use of the Cadence toolset but the laboratory experiments are structured to help navigate this learning curve. The first several experiments will ease you slowly into using Cadence Virtuoso, with this first lab focusing on access to Cadence Virtuoso and on making it run. By the end of the first experiment, you should be able to access the ECpE department's Linux servers, open Virtuoso, and switch between the Command Interpreter Window (CIW) and Layout Manager Window (LMW).

Deliverables

In future labs, a lab report will need to be written. For this lab, however, a lab report is not necessary since the purpose is just to get setup. However, if you would like to write a lab report and submit it, the TAs will "grade" the report and provide feedback so you know what to expect moving forward.

In future labs, your report will be due by the end of the day prior to the day when the next experiment is scheduled. All laboratory reports will be submitted through Canvas. **Only PDF submissions will be accepted for laboratory reports**. Late submissions will receive reduced points. Thus, if you have a lab on Tuesday which goes from 8AM to 10:50AM, your lab report is due the following Monday at 11:59 PM. As a general rule, your lab report should walk the reader through your process, what results are expected, what results were obtained, how expected results

compare with what was obtained, and what mistakes may have been made. You should never just provide data and say "this is what I got" – your interpretation of the data is critical.

In addition to a lab report, some experiments will also have a pre-lab. While it is at the discretion of the lab TAs to check the pre-lab before lab, it is to your advantage to complete the pre-lab ahead of time. The pre-lab will be related to the lab content and will ultimately save you time during lab. Even if checked before lab, the results of the pre-lab should be included in the lab report. Failing to include the pre-lab in the lab report may result in a reduced grade.

Milestones

All labs will have a small set of "milestones" that are required to be completed and shown to a lab TA. A laboratory report will be accepted only after all milestones have been demonstrated. The Milestones (alternatively checkpoints" should be shown to the lab TA during the designated lab session. If for some reason you fall behind schedule in completing a laboratory experiment, checkpoints should be shown to a TA during a later laboratory period prior to the report deadline.

For images of schematics or graphs within Cadence, always use the built-in Export Image functionality. For terminal snapshots or for a graphical window, use KSnapshot within the Linux environment.

The checkpoints for this lab are as follows:

1. Setup Cadence Virtuoso
2. Launch Virtuoso including identify the CIW and LMW
3. Creation of lab library.

Part 1: Setting up Cadence Virtuoso

The Linux environment that you got access to in Part 1 of this document is no different than Windows or MacOS except that it has a different look, feel, and set of tools available to use. You are encouraged to explore the environment a little to familiarize yourself with the graphical interface.

As a rule of thumb, in Linux, anything that you can do with the default GUI (graphical user interface) can be done more efficiently in the Terminal. We will use the Terminal frequently in labs to do things such as start Cadence Virtuoso, start ModelSim, and move files around, so it is important to get comfortable with basic UNIX commands. For now, we will stick with using the Terminal to get our Virtuoso workspace setup.

To begin setting up Virtuoso, we need to make a folder for our labs where Virtuoso will save our libraries and cell views (we will talk about these more next lab). This folder will be referred to in future labs, so it is critical that it is named correctly and located in the right place. If it is not, you

will need to adjust your Virtuoso path settings in future labs. We will call this folder the "ee330" folder.

To make this folder, run the following set of commands in the Terminal. Please note that all green text are comments; do not include them in your Terminal.

```
# Print out your current working directory:
pwd
# Change your working directory to the user directory: /users/<netID>
cd ~
# Create a directory in your current location called "ee330"
mkdir ee330
# List all folders and files in the current working directory.
#     Make sure that the "ee330" folder is present.
ls
# Change your working directory to the newly created "ee330"
#     folder. The "./" portion of the path is an abbreviation for
#     "current directory path." If you start typing the directory for
#     "ee330" and hit the tab key, it will cycle through matching
#     names and help you autocomplete.
cd ./ee330
```

Next, we need to setup the libraries we will be using and copy the Virtuoso configuration files to the project directory. For convenience, we have packaged the necessary setup commands into a single executable shell script (".sh") file. In the Linux environment, download the SetupEE330Lab.sh from Canvas and then do the following:

```
# Navigate to the downloads file, or wherever you downloaded the
#     script to
cd ~/Downloads/
# Move the script (first argument of the mv command) to the user
#     directory (second argument of the mv command)
mv SetupEE330Lab.sh ~
# Change your working directory to the user directory: /users/<netID>
cd ~
# Give read, write, and execute access to all user groups
chmod -R 777 SetupEE330Lab.sh
# Run the shell script
./SetupEE330Lab.sh
# Show the Terminal command history
history
```

When running the setup script, make sure the last line of output states "Setup Complete." If it does not, see if any errors are outputted. The most likely error is that you did not name the project folder exactly "ee330." Note that the Terminal is case-sensitive!

Once the script outputs "Setup Complete," use the "KSnapshot" tool in Linux to take a picture of the Terminal's command history. Include this screenshot in the lab report as proof of completion of checkpoint two. Once complete, close the Terminal window. While we will need the Terminal again in the next part of this lab, it is critical that you close the Terminal before continuing as

some additional background tasks that will prevent you from progressing in the next part of the lab will be closed with the Terminal as well.

Part 2: Creating your Lab Library

Now that Virtuoso's configuration files have been successfully copied and the course folder has been created, we can run Virtuoso and create the library that we will be using throughout the remainder of this course. To start Virtuoso, open the Linux Terminal and run the following commands. This is how you will start Virtuoso for the remainder of the course; it will not be necessary to rerun the setup script again.

```
# Navigate to the course folder
cd ~/ee330
# Launch Virtuoso. The "&" argument launches it in the background
virtuoso &
```

This will start the Cadence custom IC design tool, and, after a brief delay, you will see the Command Interpreter Window (CIW), as shown in below. All errors and warnings are communicated to the user through the CIW so make sure you always use it as your guide when troubleshooting.
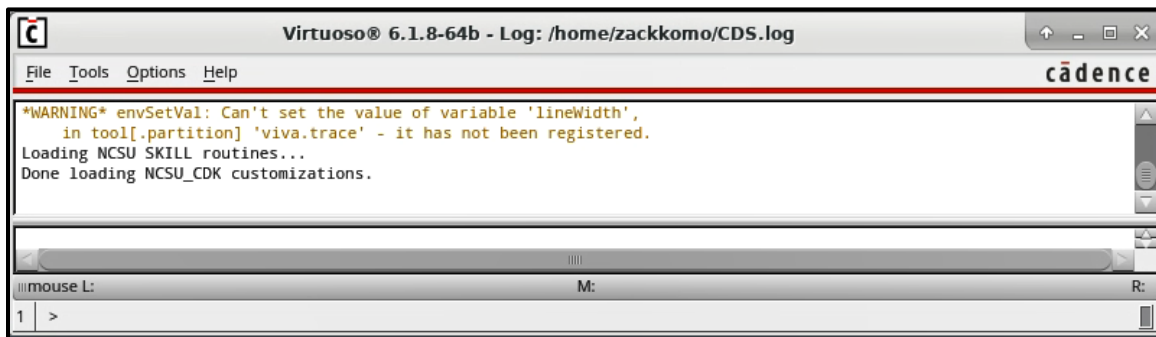

Figure 1   CIW Window

At the startup, you will also see a Library Manager Window (LMW), as shown in Fig. 2. The library manager is used to organize the data into libraries and cells. If you don't see the Library Manager Window, you probably forgot to run the virtuoso program from the ee330 folder. You can also open the window in the CIW, just click on Tools→Library Manager.
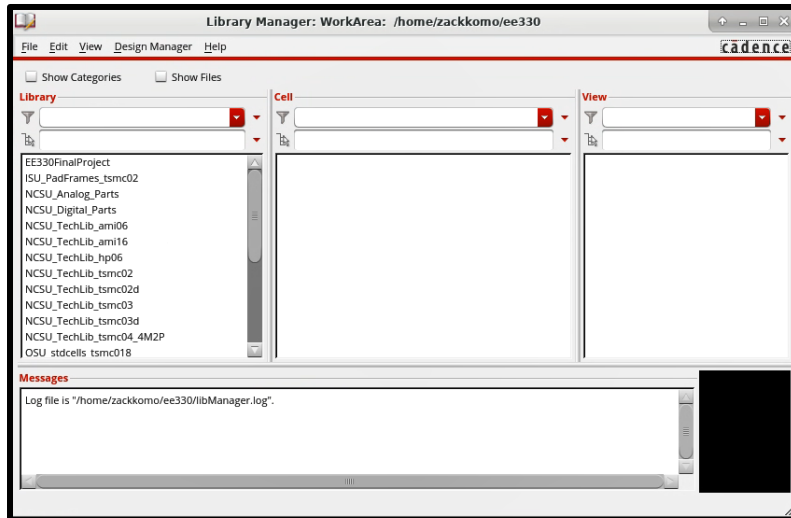
Figure 2 Library Manager Window

We now need to make our own library to use. We will group our designs in Libraries. Each library is a folder to group relevant subfolders together. Each Library can contain multiple "Cells" and each cell can have multiple "Views". Let us first create a new library called "lablib" and create cells for each lab in the library. To create a new library, go to the Library Manager and click on File→New→Library. In the form that pops up, shown in Figure 3, type in the name of the library in the Name field. On the right, under the "Technology File" section, choose "Do not need process information."   Then click on OK.
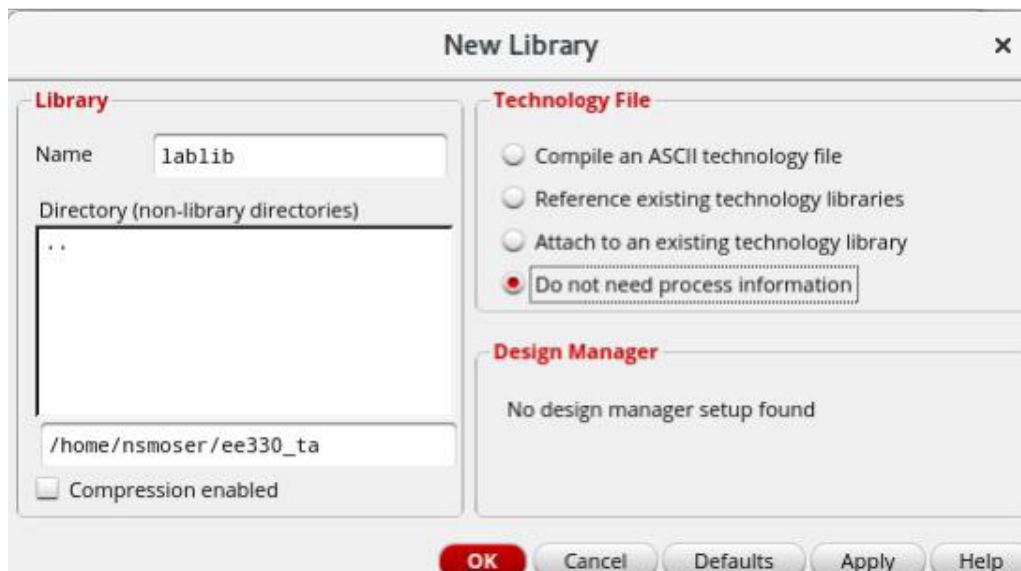
Figure 3   Library Creation Window

A new library by the name you chose, "lablib", will appear in the LMW. Using KSnapshot, take a picture of the LMW showing the "lablib" library. Show this picture to your TA.

Summary

After going through this introductory lab, you should have a Cadence Virtuoso environment which is setup and be able to launch Virtuoso. Additionally, you should be able to know what the Command Interpreter Window (CIW) and Layout Manager Window (LMW) are, since they will be referenced without images in future labs or be useful when asking for help.

Appendix A: Accessing Linux Servers Remotely

To access the Linux servers which have Cadence installed on them remotely, it is necessary to have VMware Horizon installed on your computer. If you do not have it already installed, or are unsure if you have the correct version, go to https://vdi.iastate.edu/ and click on the "Install VMware Horizon Client" button. Using the browser version has caused issues for some students in the past, so the application is recommended. This will redirect you to VMware's downloads page, which will present several clients that you can download. See the figure below.

Figure 4   VMware's download page

Choose the most up to date client that is correct for your operating system. If you are using a Mac, that would be the client listed under "VMware Horizon Client for Mac." If you are using a computer running Windows, that would be the client listed under "VMware Horizon Client for Windows." Download the client and install it as you would any piece of software on your computer. If asked for a preferred IP protocol (see Figure 5, below), select "IPv4." If not asked, do not worry about it.
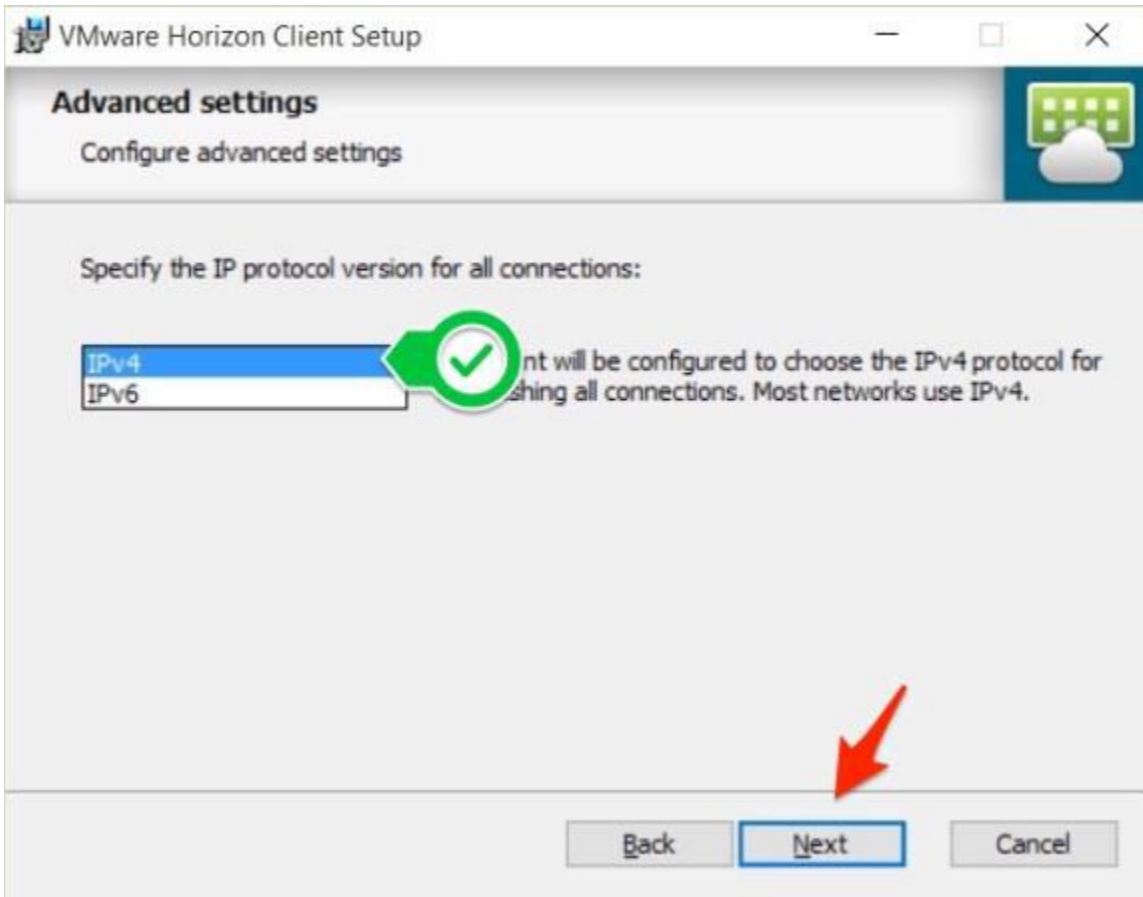
Figure 5: Configuring the client's preferred IP protocol

Once installed, open the "VMware Horizon Client" application. If you have never used VMware before, you will initially be greeted with an empty gray screen, as seen below.
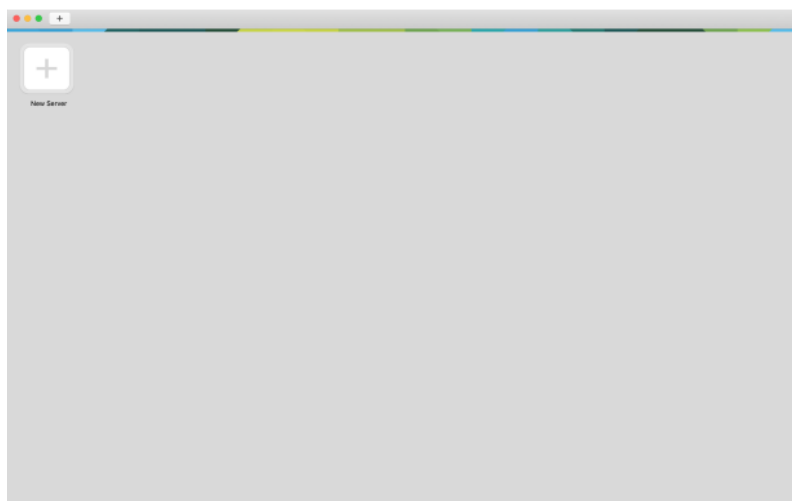

Figure 6: VMware's server screen

Click on the "New Server" button and enter "vlinux.ece.iastate.edu" into the field that pops up. This is the domain of the ECpE department's Linux servers that have Cadence products installed on them.
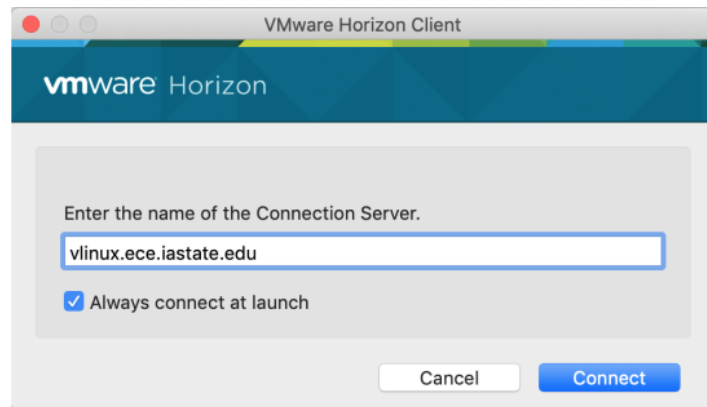

Figure 7   VMware's connection screen

Click on "Connect." A new screen should appear, asking you to login with your username and password. Enter your Iowa State email into the username field and your email password into the password field. Note that the username field specifically wants your email, not your NetID. Putting "xyz" into the username field will fail but putting "xyz@iastate.edu" will not.

Once you have entered your credentials, click "Login." VMware will then connect to the Linux server. If many students are attempting to access the server, or if your internet connection is not great, it may take several minutes for the client to connect and for the server to respond. Once the connection has been made, you will be able to login to the Linux servers using your netID and netID password.

If you would like to edit settings for the session, then on your local machine open the item tray (Windows), right click and select settings. Here you can configure your display to fit all monitors or just one. Additionally, you should consider configuring a shared folder that will be available in the client and on your local machine to pass files and images through seemlesly. In the client this is the tsclient folder in the home directory.
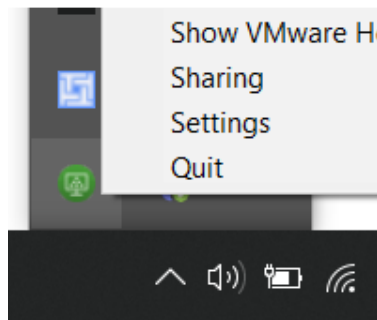

Figure 8 VMWare Options