Introduction to CCV and Cadence Virtuoso for Electronic Circuit Simulation

Introduction

ENGN1600 will be using the Cadence Virtuoso software suite for its circuit design and SPICE components. Part of the assignments and labs will include designing simple circuits with standard MOSFET components, then simulating their output characteristics in SPICE (or Spectre, which is Cadence's alternative to SPICE).

SPICE, or Simulation Program with Integrated Circuit Emphasis, is a program that takes in a circuit in list form, indicating what devices, voltage sources, etc. are included in the circuit, and where they connect. It then applies models for each component, which tell the program how components such as MOSFETS are expected to behave. Finally, it runs whatever analyses you have specified on that circuit, for example: output voltage as a function of capacitance for one of the capacitors in the circuit; or gain as a function of frequency.

This tutorial will assume no prior knowledge of the CCV cluster, VNC, UNIX, Cadence, or SPICE. If it feels slow to you, feel free to skip what you already know. This tutorial is only intended to get you started with Cadence and SPICE. Additional tutorials will be made available as necessary.

Getting Started with CCV

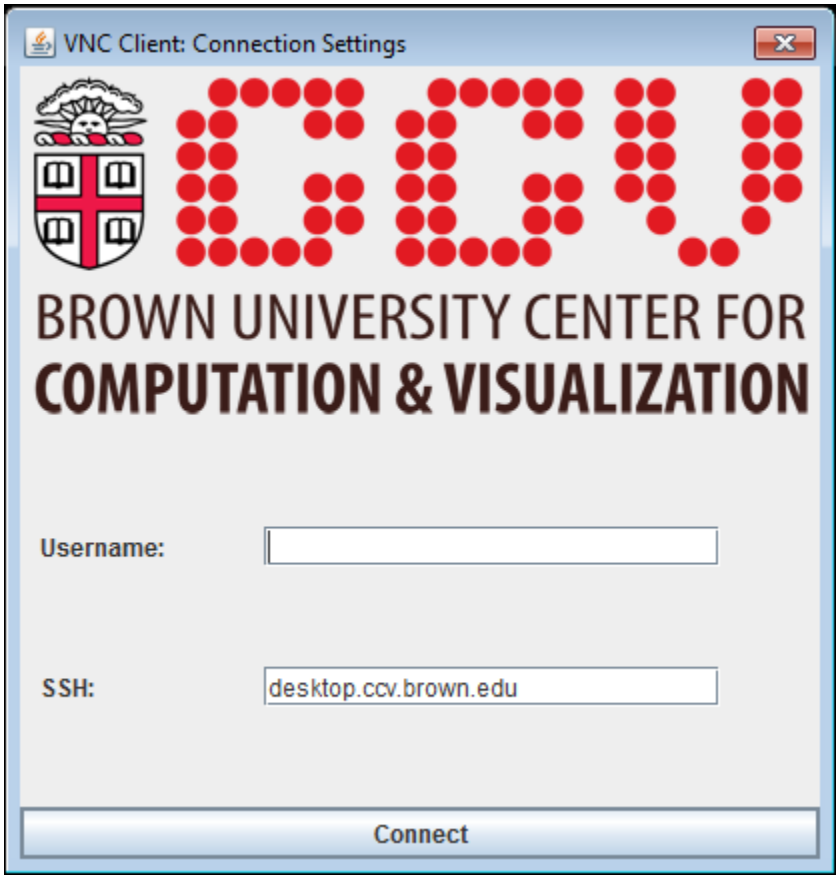
By now you should have received a piece of paper with a username and password. This will allow you to log into the Computation and Visualization cluster network at Brown, where Cadence is being hosted. A link to the full CCV user manual is included in the reference section at the end of the tutorial. You will be able to connect from the engineering computers or your personal computer, but know that you do need an active internet connection to do any work. The connection is made through VNC, a program which gives you access to a desktop on a remote computer.

The computers in the engineering lab have been set up with the CCV VNC client. You should be able to find the client in the start menu. If you need to download the client for your own use, or for use in the electronics lab, you can find the client here: https://www.ccv.brown.edu/technologies/vnc. **DOWNLOAD THE LATEST VERSION (1.7b).**

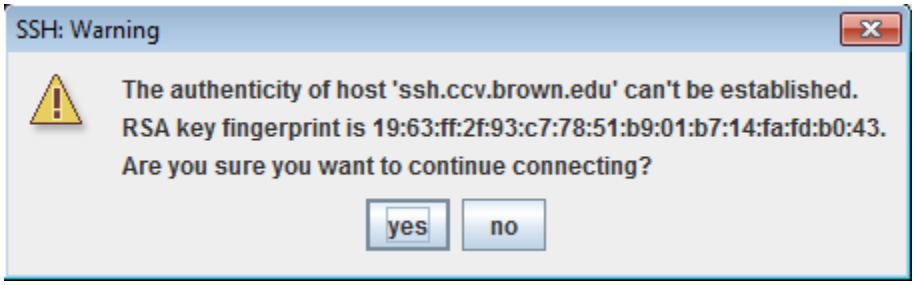
Note: You will need to have the most recent version of Java JDK or JRE installed on your machine to run the client. A link to download these as well as full instructions are provided on the VNC download page (link above).

Once the Java JDK or JRE are installed. Simply extract the standalone executable from the zip file and run it.

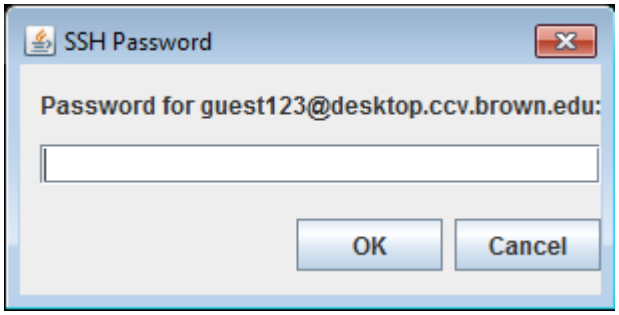
- The first window you will see should look like the image below. Type in your username, provided at the top of the sheet handed out in class, and press **connect**.



- You will likely see a window warning you about host authenticity. Press **yes**.

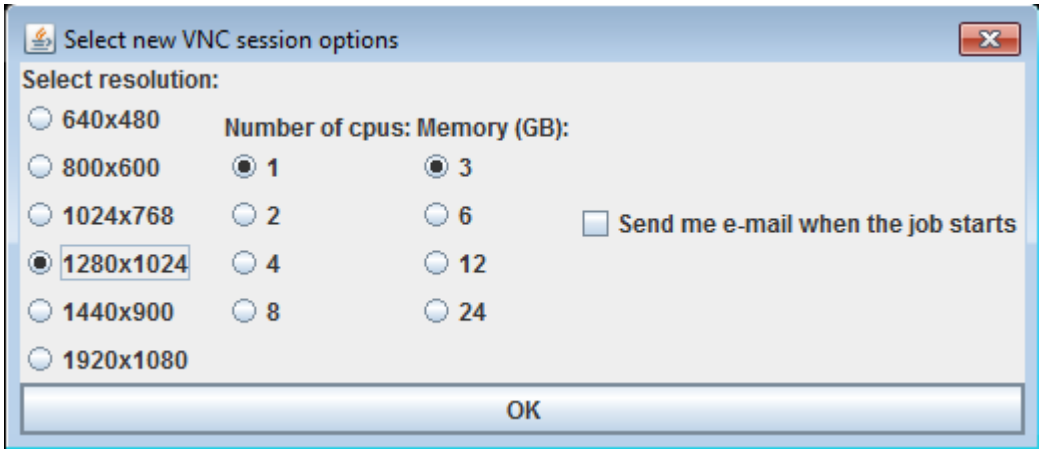


- You will be asked for your password. If logging in for the first time, enter the password provided on the same sheet as your username. You will be able to change this later. Hit **OK**.

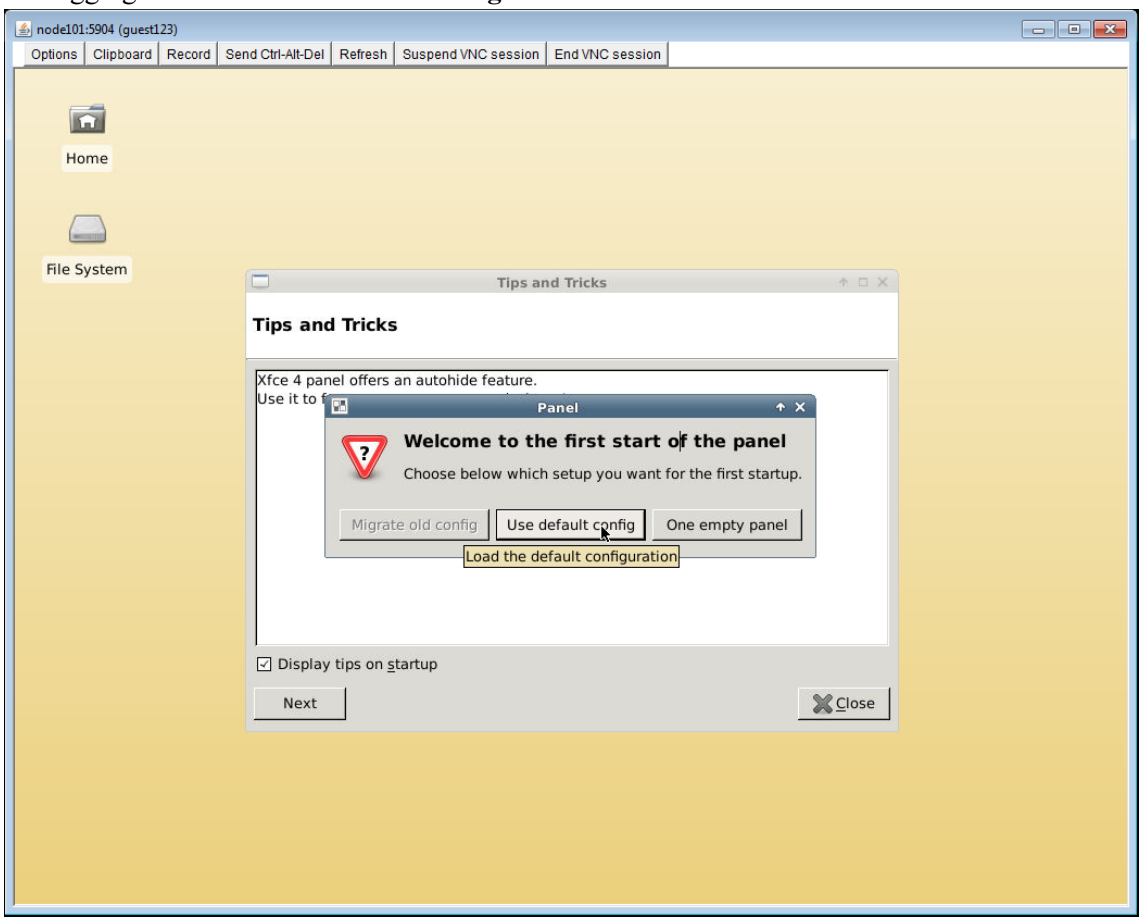


- You will be asked to select your resolution and CPU/memory options. I would recommend selecting the largest resolution that is still smaller than your total monitor resolution (for the electronics lab monitors,

1024x768). For ENGN1600, you should not need to use more than 1 CPU and 3GB of memory. Press **OK**.

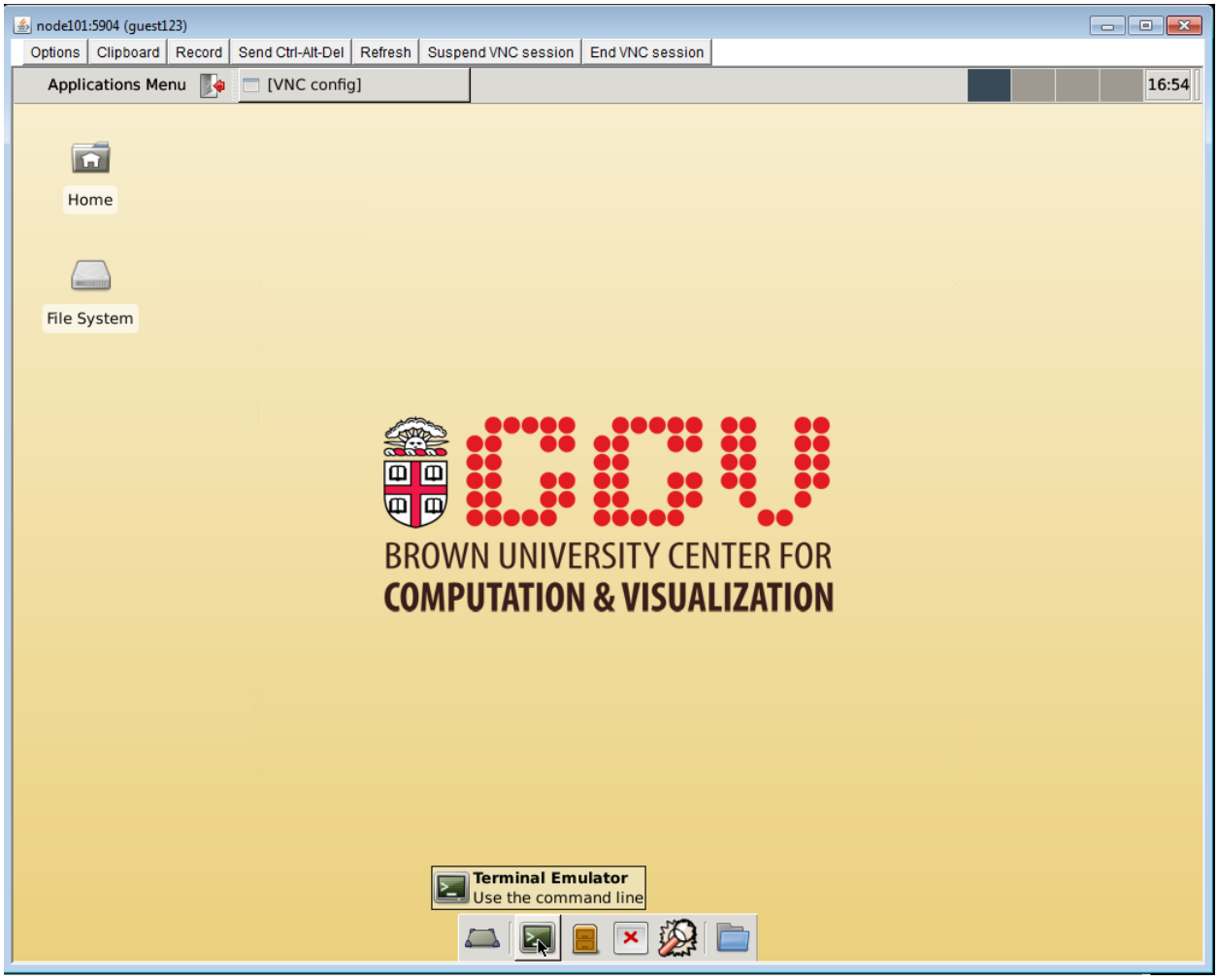


- After a few moments, you should be connected, and will see the following screen if it is the first time you are logging in. Choose **Use default config**.



Launching the UNIX Terminal and Cadence

In Unix, your most useful tool is the terminal. This gives you command line access to all of your programs and files, as well as configuration options. A shortcut to the terminal is located on the dock, or in the applications menu.



You should be able to do everything necessary for ENGN1600 without extensive knowledge of how to use a Unix terminal, or shell, but if you're interested, check the references at the end of the tutorial for a quick guide you can start out with.

For now, please do not change your password. Once we have confirmed that it is safe to change your password, we will send out instructions on how to do so.

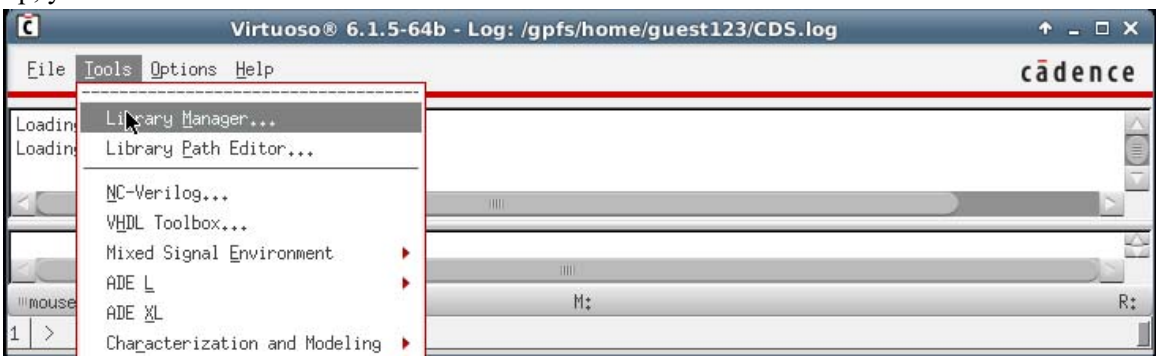
Before launching Cadence you need to copy the script we will use to run it.

- From inside your home directory type `cp /gpfs/runtime/opt/cadence/shared/FreePDK45/run_cadence.sh .`

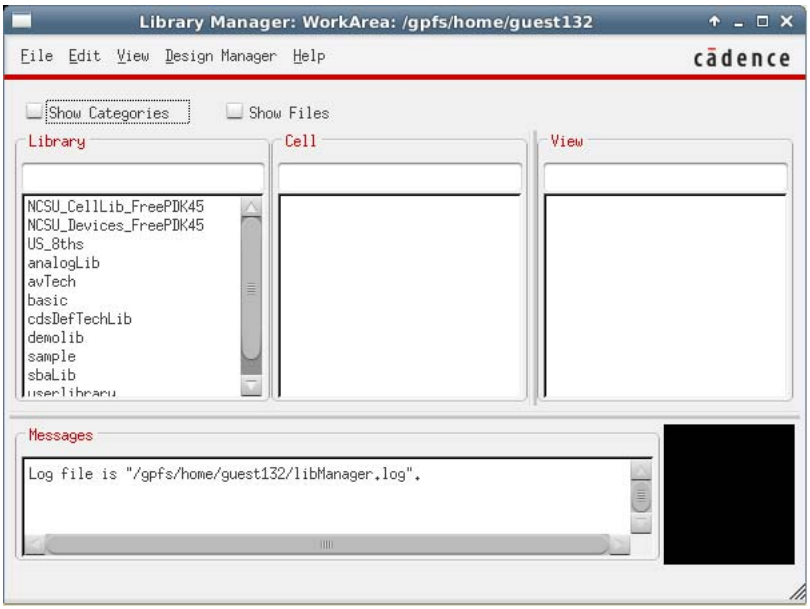
Next, we'll launch Cadence.

- Type `./run_cadence.sh`
- After a few moments, you should see a splash screen, and then a window titled "Virtuoso® 6.1.6-64b …" This is the main window for Cadence. Closing it will exit the program. If a "What's New" window pops

up, you can close it.



- From the menu in Virtuoso, click Tools→Library Manager… - this will launch the library manager, your main starting place for any work you need to do.



The Library Manager

All the files you will need for ENGN1600 can be found in the Library Manager. The manager consists of three menus: Library, Cell, and View. Each "library" contains some number of "cells", which can be devices, test circuits, or whole designs. Some useful libraries are:

- *NCSU_CellLib_FreePDK45* and *NCSU_Devices_FreePDK45*: These libraries consist of 45nm integrated CMOS devices and circuits for ENGN1600.
- *US_8ths* consists of templates for your schematic, if you want to add a title block and grid for printing purposes. These cells will not change the functionality of your circuit.
- *analogLib* contains analog circuit components primarily needed for ENGN1620..
- The *basic* library also contains components like voltage supplies, grounds, etc. You can use parts from either *analogLib* or *basic*, but I highly recommend remaining consistent within your circuits (i.e., don't use the VDD cell from basic and also the vdd from *analogLib*).
- *demoLib* contains a number of demo circuits constructed for ENGN1620 that you can use as references when creating your own circuits.

(Note that each “library” is actually a directory. For those slightly more familiar with Linux, your “userlibrary” is located in ~/userlibrary/.)

Also note that each “cell” can have multiple “views”. For example, an opamp cell could have a “schematic” view showing the internal circuitry controlling the opamp, as well as a “symbol” view showing only the opamp triangle with input and output terminals for inserting into another circuit. You would generally add “symbol” views of other cells into your schematics. For a few examples of various views, check out the various views each cell in the *sample* library has.

References/Other Useful Sources

- The full CCV user manual and documentation: https://www.ccv.brown.edu/support
- A quick and dirty introduction to some common UNIX terminal commands. The commands under Files and Directories are the most useful. http://cs.brown.edu/courses/bridge/1998/res/UnixGuide.html
- A very good reference on SPICE commands: http://www.seas.upenn.edu/~jan/spice/spice.overview.html