OSSIE Lab2: Using Reconfigurable Component Properties

Frank Kragh, Nathan Beltz
Naval Postgraduate School, Monterey, CA,
Drew Cormier, Carl Dietrich
Virginia Tech, Blacksburg, VA

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1 acknowledgments

This lab was developed with the assistance of Philip Balister, Chris Phelps, Jacob DePriest, Jeff Reed, and Max Robert of the Mobile and Portable Radio Research Group, Wireless@Virginia Tech (http://www.mprg.org, http://wireless.vt.edu) and uses the OSSIE open source SCA software radio framework and components (http://ossie.mprg.org). This work was supported in part by NSF award #0520418.

2 objective

This laboratory exercise gives students an opportunity to build a waveform and to experiment with overriding the default value of a component property in a waveform. A simple waveform will be constructed which simulates an extremely basic QPSK communication system. QPSK data will be sent through a linear amplifier before being sent through an AWGN channel. After the noise is added to the signal, the resulting noisy data will be plotted. The amplifier gain will be increased to improve the signal to noise ratio.

3 version

This lab was is designed and tested on OSSIE and OWD version 0.6.1 running on a computer or VMware image that uses Fedora Core 5 Linux. The QPSK_mod, amplifier, AWGN_complexShort, and Graph components are required. The current Graph component requires ACE.

4 rules

You may not collaborate with other students on the lab report. You may discuss any aspect of this assignment except the report with anyone, including asking questions, getting advice, etc. You may not share any files generated in this assignment with any other ECE 5674 students. Ideally, you will complete the process described in the procedure yourself (individually). If this is not possible due to a lack of sufficient machines, look on or take turns with classmates. When you have completed the exercise, submit a very short lab report via the digital dropbox link in Blackboard. The lab report should be in MS Word (*.doc), Adobe Acrobat (*.pdf), or ASCII text (.txt) format and be organized as follows:

1. Your name
2. Suggestions
   Any suggestions you have for improving this laboratory experience.

3. Questions
   At least 2 questions regarding this lab experience (These should be questions not answered in this assignment sheet and relevant to the assignment.). Your questions will help me prepare my classroom follow-up to this assignment, and perhaps improve future instantiations of ECE 5674.

4. Attestation
   The statement "I have completed the ECE 5674 Lab 2 assignment and complied with the rules." or the statement "I have not completed the ECE 5674 Lab 2 assignment or not complied with the rules." The second statement requires explanation.

5 terminology

♢ GPP = General Purpose Processor (e.g. the processor in a PC).

♢ CORBA = Common Object Request Broker Architecture

♢ SCA = Software Communications Architecture

♢ OSSIE = Open Source SCA Implementation::Embedded

♢ OWD = OSSIE Waveform Developer

♢ Fedora Core 5 = a freeware version of Linux available from Redhat.

♢ waveform = your communications system design.

♢ component = a communications system function that is implemented is software. Modularity of the software is desired, so components often implement very simple functions with multiple components connected to implement more complex functions.

♢ device = hardware that will execute functions defined in components and waveform. Examples: GPPs, FPGAs, DSPs, USRP, etc.

♢ node = a device or group of devices.

♢ uses port = usually (but not always) an output

♢ provides port = usually (but not always) an input

6 useful Unix stuff

♢ *pwd* = print working directory

♢ *ls* = list files

♢ *cd* = change directory

♢ <CTRL>*Z* = suspend process (application)

♢ *./* = current directory

♢ *../* = parent directory of the current directory

♢ *~* = home directory for your login.

♢ */* = root directory

7 procedure

1. Getting started.
   (a) Boot the computer.
   (b) If using the VMware image, start the the VMware player and load the image.
   Login using (username = ossie) and (password = mprgossie). Both are CaSe sensitive. Also (root password = wireless).
   (c) Open a shell. Either point mouse to upper left of screen and navigate Applications → system tools → terminal. Alternatively, you can click on the shortcut (if it is there) that looks like a computer screen in the toolbar at the top of the computer display.
   (d) Navigate to directory /home/ossie/src/WaveDev/wavedev. To do this, type *cd ~/src/WaveDev/wavedev* or */home/ossie/src/WaveDev/wavedev*. Note: If a directory is uniquely specified by the first few letters, you can use the tab key to save keystrokes. E.g. In lieu of typing *cd /home/ossie/src/WaveDev/ wavedev*, try typing *cd /h<Tab>o<Tab> s<Tab>W<Tab>w<Tab>*.
   (e) Launch the OSSIE Waveform Developer (OWD). Type *python wd.py*
2. Using the OSSIE Waveform Developer.
   (a) Name your waveform. Type a name in the box labeled "Waveform Name". Remember your name should have no spaces. Please use the format of: <Lastname>Lab1 with no spaces in the title (or the waveform will not operate correctly).
   Note: You may save your work at any time by saving your OWD project file (file suffix is "owd") Use the OWD menu: "File → Save Project As...". Please save the Project file under the default of /home/ossie if you prefer.
   (b) The waveform will first be created using default property values.
      i. Add a node to your design. This represents the computer or radio where your components will run. On the OWD menu, navigate: Platform → Add deployment node. Name your node [default = Node1].
      ii. Add the GPP to your node. Click on the triangle that points to "Devices" to expand the list of available devices. For this lab, there will be multiple devices available, including the computer you are working on "GPP". Right-click GPP, under Devices, and select "Add to Node". Name your GPP [default = GPP1]. In general, you would now specify the deployment node. But since you only have one node, the default deployment node will be correct.
      iii. You will then need to add 4 components for your waveform: QPSKmod, amplifier, AWGNChannel_complexShort, and Graph. Add the components as follows: click on the triangle that points to "Components" to expand the list of available components. Right click on the component you want to deploy (start with QPSKmod), and select "Add to waveform", repeat for each component.
      iv. Deploy each component onto the node and device. One at a time double-click each component in the "waveform layout" panel. The OSSIE Component Editor window opens. Under "Deployment Settings", click on the box next to your "Node" (not outside the box). When your node name appears in the window [default = Node1], press <Enter >. If your device does not appear in its box keep clicking inside the box until it does. After the name appears in the "Node" box click inside the box next to "Device" to select your GPP Device [default = GPP1]. Close the OSSIE Component Editor window.
      Note 1: if nothing appears in the "Device" window go back to the "Node" window and click again several times. Close the OSSIE Component Editor window. Repeat for each of the other components.
      Note 2: as a precaution after all components under "Waveform Layout" have been

completed go back into each component individually by double-clicking to verify that the "Node" and "Device" under the "Deployment Settings" are selected correctly before moving on.

v. Set QPSKmod as the assembly controller. Each waveform must have exactly one Assembly Controller. When you run your waveform, the first thing that happens is the start() function of the assembly controller is called. The assembly controller then starts and stops the other components as needed. Therefore, the Assembly Controller must have the ability to start first, i.e. to initiate its function without input from any other component in your waveform. For this waveform, this needs to be QPSKmod. (Double-click your QPSKmod component [default = QPSKmod1] in the "waveform layout" panel. Check the Assembly Controller checkbox in the OSSIE Component Editor window. Close the window.) Notice that the Assembly Controller is listed in **bold** font in the waveform layout.

vi. At this point, the component ports must be connected. Right click on QPSKmod1 and select "Connect." The Connections dialog box will be opened. Select "outPortTx1" from the QPSKmod1 ports (on the left). On the right side of the dialog box select the "dataIn" port under "amplifier1." Once both ports have been selected, click on the "Connect" button in the center of the dialog box. Verify that the correct connection is listed under "Connections," then click the "Ok" button.

vii. Connect amplifier output to AWGN channel input. Right click on amplifier1 and select "Connect." The Connections dialog box will be opened. Select "dataOut" from the amplifier ports (on the left). On the right side of the dialog box select the "inPort" port under "AWGNChannel_complexShort." Once both ports have been selected, click on the "Connect" button in the center of the dialog box. Verify that the correct connection is listed under "Connections," then click the "Ok" button.

viii. Connect "outPort" from the AWGNChannel_complexShort1 ports to the "TwoDim Short" port under "Graph1." Not all of the component ports available have been connected. This is ok...

ix. Name the waveform if you have not already.

x. Generate the files that define the waveform. Select Waveform → generate → from the OWD menu. In the window that appears, note that the default directory is */home/ossie/src/WaveDev/wavedev"* - **do not save the files here**. Instead, enter the directory path */home/ossie/src/waveforms* into the highlighted box. Click "OK". A directory will be created */home/ossie/src/waveforms/<your waveform name>* and will hold all the files that define your waveform.

xi. Save your work by saving your OWD project file (file suffix is "owd") Use the OWD menu: "File" → "Save Project As...". Please use the default directory is to save your file: **/home/ossie**. Remember to save it because you will need to reopen the project file to edit the waveform.

xii. Close the OWD (File → Exit).

3. Install the waveform. The process for installing the waveform is the same as in Lab 1 and described below.

   (a) Open a terminal, and navigate to the location of the source code of the waveform. Type *cd /home/ossie/src/waveforms/<your waveform name>*.

   (b) Type the following three commands, waiting for the command prompt after each:
   ./reconf
   ./configure
   su -c "make install" [root password = wireless]

4. Once the waveform is installed, the waveform can be run using the process detailed below.

   (a) Navigate to /home/sca/waveforms/<your waveform name>. (Type *cd /home/sca/waveforms/<your waveform name>*)

(b) Ensure that CORBA Naming Service is running. Type *omniNames.sh<Enter><Enter>* at the prompt in a shell. When it completes, it will display "checkpointing completed". Press <Enter> to return to the prompt.

(c) Start the Domain Manager and register your device with the Domain Manager by running the nodeBooter program. Type *nodeBooter -D -d DeviceManager.dcd.xml* When this action completes, the shell will display "Device Registered".

(d) **Open another shell**, navigate to /home/sca/waveforms/<your waveform name>, and run wave loader. Type *wavLoader.py <your waveform name>_DAS.xml*. Choose selection "1". You may have to wait for a while at this point, especially if using the VMware image. Choose selection "s" to launch your waveform.

(e) When the waveform is installed, a window labeled "Demodulator" with an empty graph should appear. When the waveform is started, random data should appear on the graph as a constellation diagram. The default gain on the transmitterś amplifier is set to 1 (0 dB), and noise will be dominating the data which is being output to the graph.

5. To get a more meaningful constellation diagram, the gain on the amplifier must be increased.

6. Begin by going back to the shell in which you started wavLoader. Follow the screen directions to stop and uninstall your application and exit from wavLoader.

7. Do this step only if you exited wd.py. Restart wd.py. Select file → open from the file menu. Navigate to the directory where you saved your project "owd" file. Select the waveformname.owd file (where "waveformname" is the name you previously gave to your waveform). The waveform layout that was previously created will be opened.

8. The gain of the amplifier component is a property which can be modified by right clicking on the amplifier in the waveform layout and selecting "Edit." At the bottom left of the OSSIE Component Editor the gain can be seen. The default value of the gain (1) will be displayed under "Instance Values." Click on the gain value (1) and change it to something larger (e.g., 32).

   Close the Component Editor and generate the files that define the waveform. Select Waveform → generate → from the OWD menu. In the window that appears, note that the default directory is */home/ossie/src/WaveDev/wavedev"* - **do not save the files here**. Instead, enter the directory path */home/ossie/src/waveforms* into the highlighted box. Click "OK". If the waveform title is kept the same the generation will write over the files */home/ossie/src/waveforms/<your waveform name>*. If a new file name is created a new folder will be created that will hold all the files that define your new waveform.

   Reinstall the waveform.

   (a) Open a terminal, and navigate to the location of the source code of the waveform. Type *cd /home/ossie/src/waveforms/<your waveform name>*.

   (b) Type the following three commands, waiting for the command prompt after each:
   ./reconf
   ./configure
   su -c "make install" [root password = wireless]

9. Rerun the waveform.

   (a) Navigate to /home/sca/waveforms/<your waveform name>. (Type *cd /home/sca/waveforms/<your waveform name>*)

   (b) Ensure that CORBA Naming Service is running. Type *omniNames.sh<Enter><Enter>* at the prompt in a shell. When it completes, it will display "checkpointing completed". Press <Enter> to return to the prompt.

(c) Start the Domain Manager and register your device with the Domain Manager by running the nodeBooter program. Type *nodeBooter -D -d DeviceManager.dcd.xml* When this action completes, the shell will display "Device Registered".

(d) **Open another shell**, navigate to /home/sca/waveforms/<your waveform name>, and run wave loader. Type *wavLoader.py <your waveform name>_DAS.xml*. Choose selection "1". You may have to wait for a while at this point, especially if using the VMware image. Choose selection "s" to launch your waveform.

(e) When the waveform is installed, a window labeled "Demodulator" with an empty graph should appear. When the waveform is started, data should appear on the graph as a constellation diagram.

You should now see a more reasonable looking QPSK constellation diagram.

10. Go back to the shell in which you started wavLoader. Follow the screen directions to stop and uninstall your application and exit from wavLoader.

11. Log out of the computer. (Point mouse to upper left of screen and navigate Desktop → log out.