MicroZed/PicoZed: lwIP Echo Server

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Version 2016_2.01

Overview

A more advanced topic that can be investigated with our hardware platform is Ethernet connectivity. Lightweight IP (lwIP) is an open source TCP/IP networking stack for embedded systems. The Xilinx® Software Development Kit (SDK) provides lwIP software customized to run on various Xilinx embedded systems, including the ARM®-based Xilinx Zynq®-7000 All Programmable (AP) SoC. This document describes how to use the lwIP library to add networking capability to an embedded system. In particular, lwIP is utilized to develop an echo server. Additional applications can be investigated by reading Xilinx Application Note XAPP1026: LightWeight IP Application Examples.

Objectives

When this tutorial is complete, you will be able to:

- Generate a board support package that includes lwIP
- Create an example design for the Echo Server
- Run the Echo Server

Experiment Setup

Software

The software used to test this reference design is:

- Windows-7 64-bit
- Xilinx SDK 2016.2
- Silicon Labs CP201x USB-to-UART Bridge Driver
  - www.microzed.org → Support → Documentation → MicroZed Silicon Labs CP210x USB-to-UART Setup Guide
  - Note that MicroZed and both PicoZed FMC Carriers all use the same Silicon Labs CP2104 device, so the setup is the same.
- Tera Term or another terminal emulator
  - We will be booting outside of the SDK environment, so we will use an external terminal as well.
  - For additional information on setting up Tera Term, see the *USB-to-UART Setup Guide* listed above.

Hardware

The hardware setup used to test this reference design includes:

- Win-7 PC with the following recommended memory[1]:
  - 1.6 GB RAM available for the Xilinx tools to complete a XC7Z010 design
  - 2.3 GB RAM available for the Xilinx tools to complete a XC7Z015 design
  - 1.9 GB RAM available for the Xilinx tools to complete a XC7Z020 design
  - 2.7 GB RAM available for the Xilinx tools to complete a XC7Z030 design
- One of the following:
  - Avnet MicroZed 7010 or 7020
  - Avnet PicoZed 7010, 7015, 7020, or 7030 with either the PicoZed FMC Carrier V1 or PicoZed FMC Carrier V2
- USB cable (Type A to Micro-USB Type B)
- JTAG Programming Cable (Platform Cable, Digilent HS1, HS2, or HS3 cable)
  - If you don't already have a JTAG Cable, Avnet recommends the Digilent HS3 Cable
  - http://www.em.avnet.com/jtaghs3
- microSD card
- microSD card adapter

[1] Refer to www.xilinx.com/design-tools/vivado/memory.htm

Experiment 1: Create the Echo Server Application

The first step is to create the Echo Server application. This is a C program that provides a simple demonstration on how to use the light-weight IP stack (lwIP).

Similar to the flow for creating the Hello_World application, in SDK create a Light Weight IP stack application.

1. Launch SDK and open the workspace from the Hello World project.
2. **File → New → New Application Project**
3. Name it something like lwIP_Echo_Server_Test and **Create New** BSP. The reason for creating a new BSP is that the lwIP_Echo_Server application requires a BSP that contains a lwIP141 library, and the tools will automatically include this for us if we allow it to create the BSP. Click **Next**

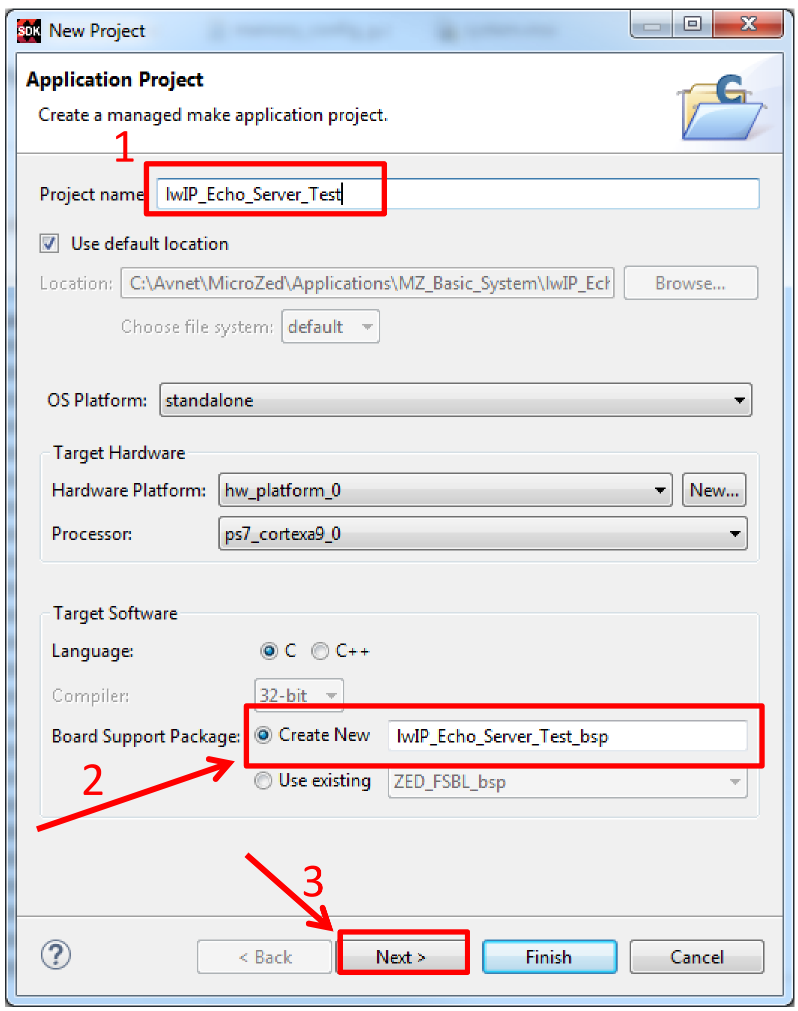


Figure 1 – Echo Server Application

4. Select **lwIP Echo Server**

5. Click **Finish**

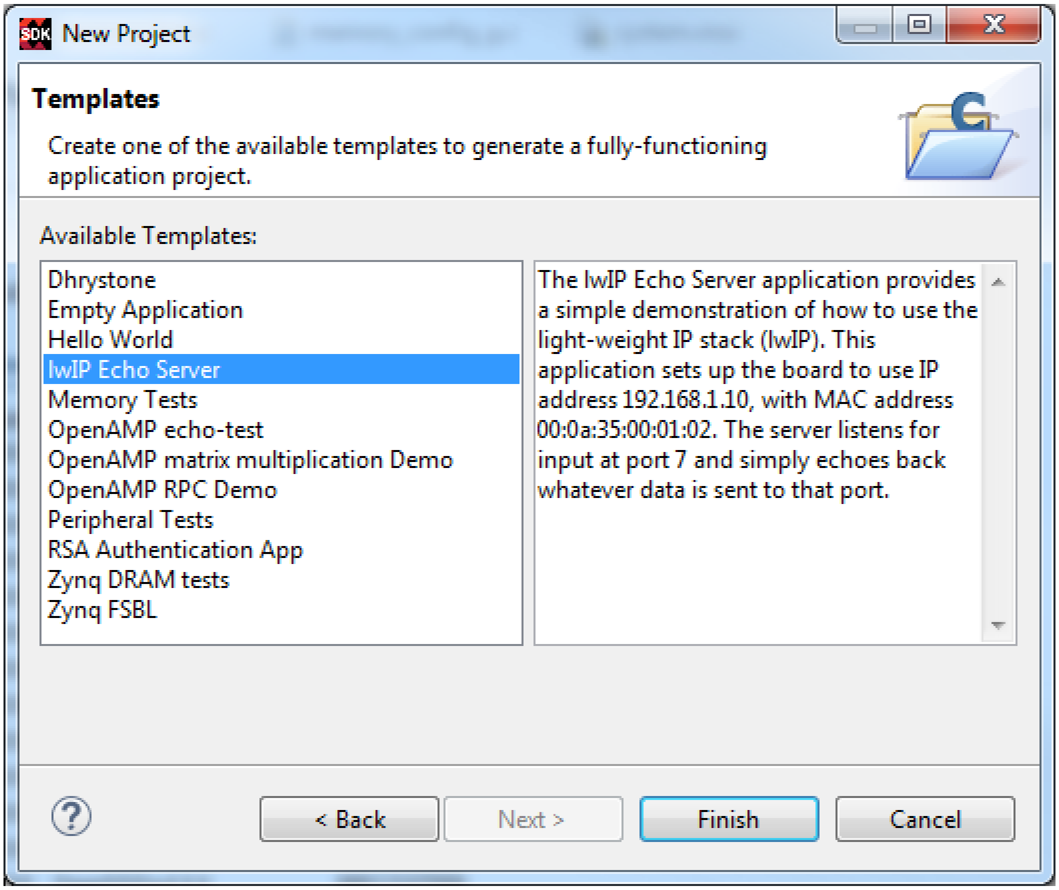


Figure 2 –lwIP Server Template Application

Here is the resulting application and Board Support Package created in the Project Explorer window.

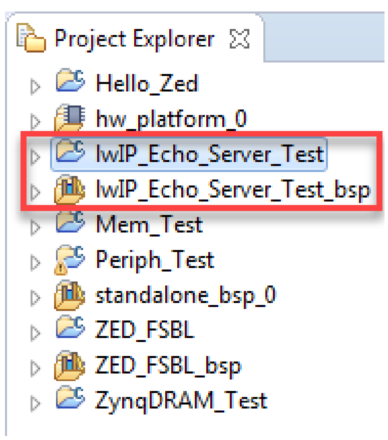


Figure 3 –Project Explorer View

6. Now lets open the lwIP_Echo_Server_Test_bsp system.mss file to see that the lwip library was added to the BSP. **Double click** on the system.mss file.

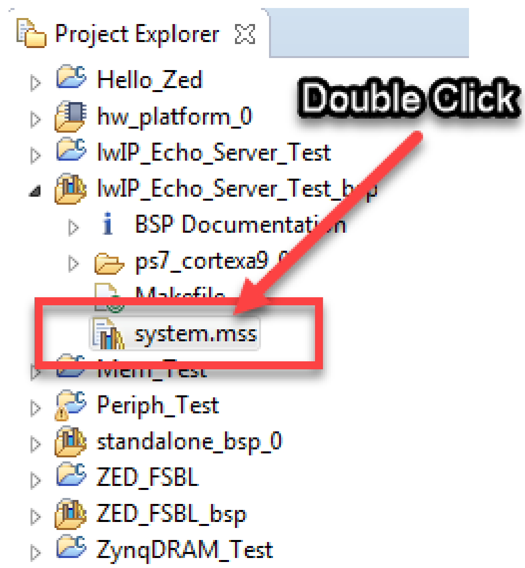


Figure 4 – System.mss File

7. **Scroll** to the bottom of the system.mss file and you will see that the lwip141 library has been added to the BSP. For more information on the library click on the documentation link next to the library.

Figure 5 – lwIP Library Added to BSP

Experiment 2: Setup Hardware to Run Echo Server Application

1. Set the Boot Mode jumpers to Cascaded JTAG Mode.

    a. MicroZed: MIO[5:2] = GND. Set JP3, JP2, and JP1 to positions 1-2.

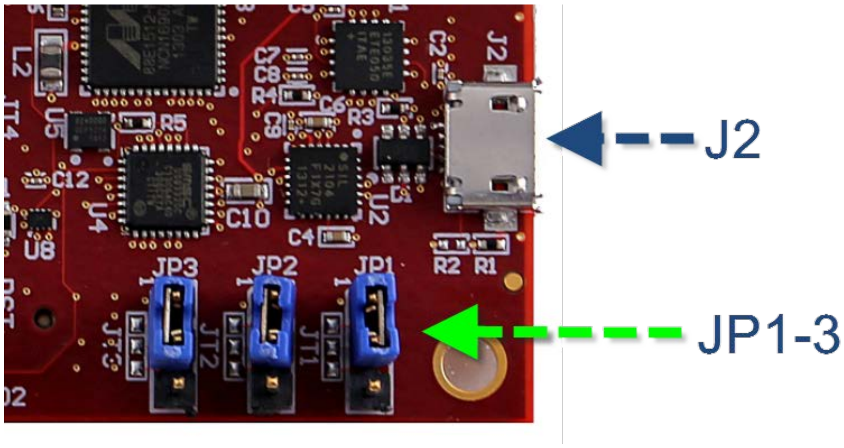


Figure 6 – Cascaded JTAG Boot Mode on MicroZed

    b. PicoZed: Set both switches on SW1 on the SOM away from the SW1 silkscreen

Figure 7 - PicoZed SW1 Set to Cascaded JTAG Boot Mode

Neither MicroZed nor PicoZed has on-board USB JTAG programming. Thus it requires an external JTAG programmer, such as the Digilent HS3.

2. Connect a Platform Cable or Digilent Programming cable from your PC to the 2x7 JTAG socket.
    a. MicroZed:
        i. Use J3
    b. PicoZed FMC Carrier V1:
        i. Use J12 – PC4_JTAG
    c. PicoZed FMC Carrier V2:
        i. Use J7 – JTAG

3. Power the board and connect a USB cable from your PC to the USB-UART port.
    a. MicroZed:
        i. Plug the micro-USB into J2.
        ii. The USB cable will power MicroZed. You should see the Green Power Good LED (D5) and the Red User LED (D3) light.

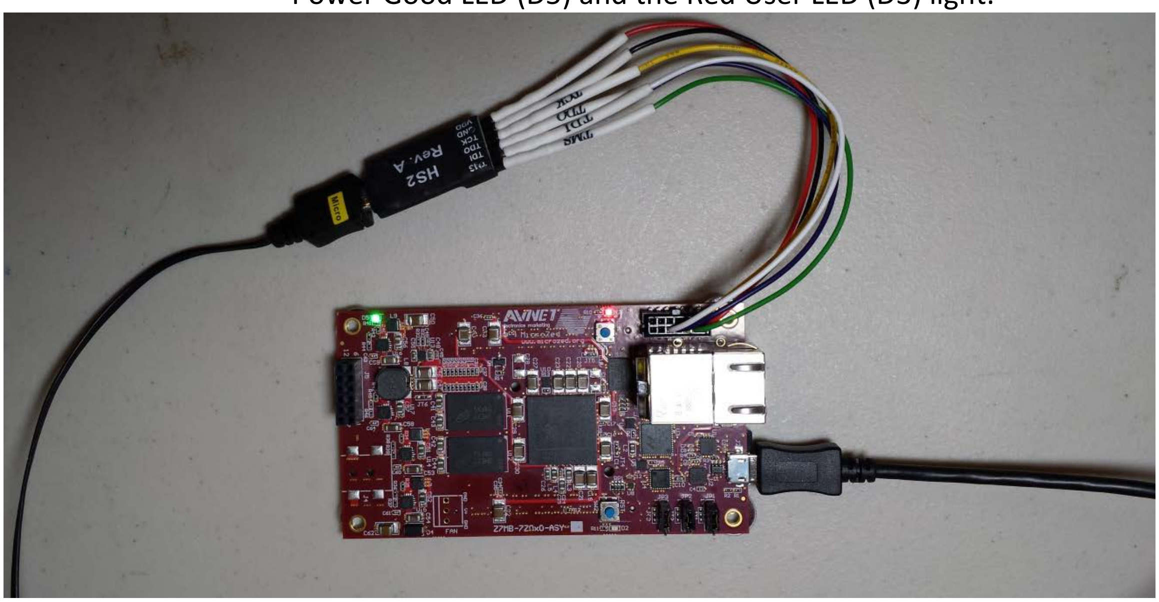


Figure 8 – MicroZed Powered and Connected to Digilent HS2 and USB-UART

b. PicoZed:
   i. Make sure the PZCC-FMC power switch (SW7) is OFF.
   ii. Insert the PicoZed module onto the PZCC-FMC.
   iii. Set the on-board jumpers as follows
      1. JP1 is open
      2. JP3 is closed in position 1-2
      3. JP4 is closed
      4. JP6 is open
      5. J9 is closed in positions 3-5 and 4-6
      6. CON2 is open, which sets V_ADJ to 1.8V
   iv. Insert the appropriate country plug into the 12V AC/DC adapter. Plug it into the J14 2x3 power connector. (NOTE – this 2x3 connector is NOT compatible with ATX power supplies.)
   v. Turn the PZCC-FMC power switch (SW7) to the ON position.
   vi. Plug in the micro-USB cable to PZCC-FMC USB-UART port (J6). (The reason for waiting until AFTER power is applied to the board is explained in the PZCC-FMC Errata.)
   vii. After 1-2 seconds, you will notice five LEDs that are lit:
      a. D1 (green) on PicoZed, indicating Power Good
      b. D19 (green) on PZCC-FMC, indicating Vin is on
      c. D14 (green) on PZCC-FMC, which is the PG_MODULE handshake between the SOM and the Carrier indicating that the SOM power is good
      d. D21 (blue) on PZCC-FMC indicating that the Zynq PL configuration is DONE
      e. D6 (amber) indicating the USB-UART is connected

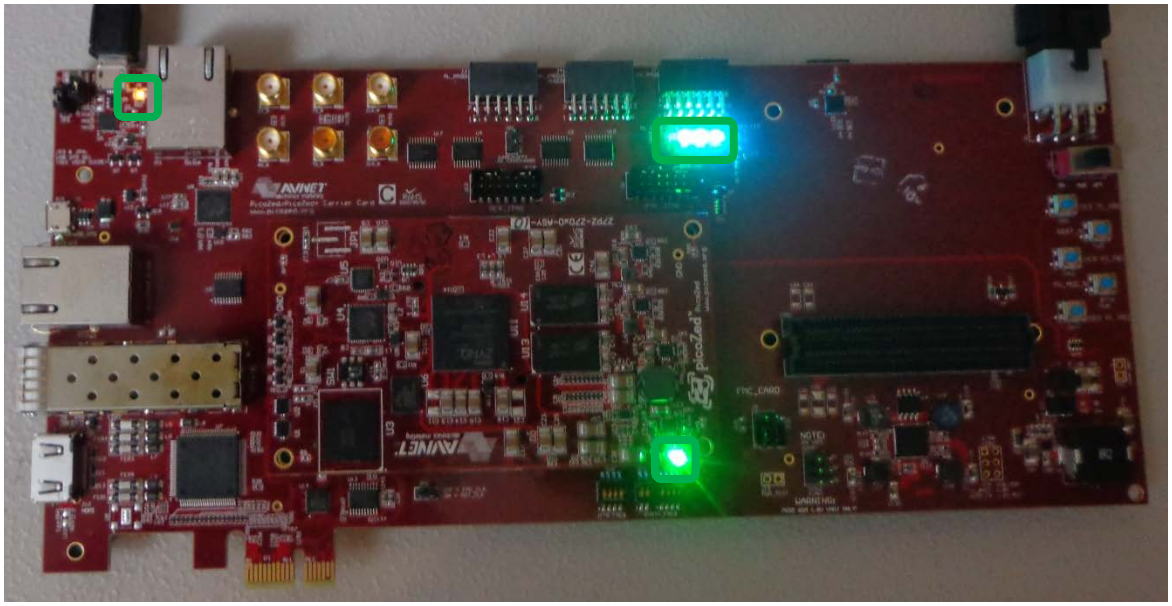


Figure 9 – PicoZed / PZCC-FMC V1 Powered On with LEDs

c. PicoZed FMC V2:
   i. Make sure the PZCC-FMC power switch (SW7) is OFF.
   ii. Insert the PicoZed module onto the PZCC-FMC.
   iii. Insert the appropriate country plug into the 12V AC/DC adapter. Plug it into the J2 2x3 power connector. (NOTE – this 2x3 connector is NOT compatible with ATX power supplies.)
   iv. Turn the PZCC-FMC power switch (SW7) to the ON position.
   v. Plug in the micro-USB cable to PZCC-FMC USB-UART port (J6).
   vi. After 1-2 seconds, you will notice five LEDs that are lit:
      f. D3 (green) on PicoZed, indicating Power Good
      g. D5 (green) on PZCC-FMC, indicating Vin is on
      h. D4 (green) on PZCC-FMC, which is the PG_MODULE handshake between the SOM and the Carrier indicating that the SOM power is good
      i. D3 (blue) on PZCC-FMC indicating that the Zynq PL configuration is DONE
      j. D1 (amber) indicating the USB-UART is connected

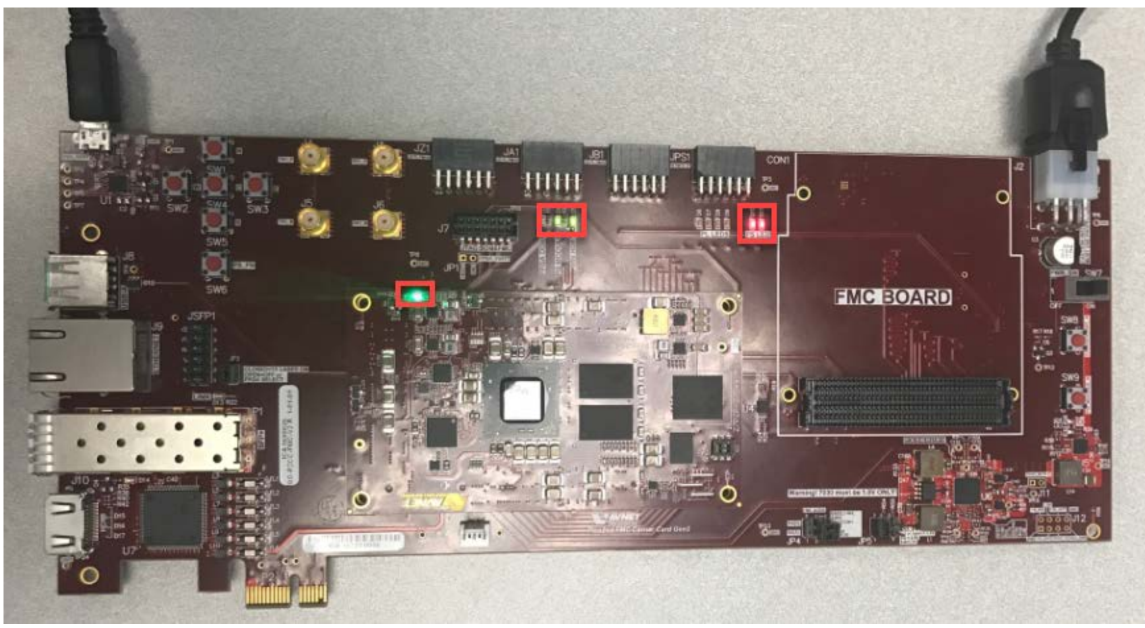


Figure 10 – PicoZed / PZCC-FMC V2 Powered On with LEDs

If this is the first time you've connected the MicroZed, PicoZed, and/or the JTAG cable to this computer, you may see Windows install device drivers for the USB-UART and/or the JTAG cable. You should have previously installed the driver for the Silicon Labs CP2104 USB-UART. The Platform Cable and Digilent USB-JTAG drivers were installed during the Xilinx tool installation.

4. Configure your PC to have a Static IP Address
5. Plug in an Ethernet cable into your device.
    a. MicroZed 7010/7020
        i. Plug Ethernet cable into J1 connector
    b. PicoZed FMC Carrier Card V1
        i. Plug Ethernet cable into J1 connector
    c. PicoZed FMC Carrier Card V2
        i. Plug Ethernet cable into J9 connector
6. Plug the other end of your Ethernet cable into your PC.
7. Use Device Manager to determine the COM port for the Silicon Labs CP201x USB-UART. In Windows 7, click **Start → Control Panel**, and then click **Device Manager**. Click **Yes** to confirm.
8. Expand ***Ports***. Note the COM port number for the SiLabs Serial device. This example shows COM4.

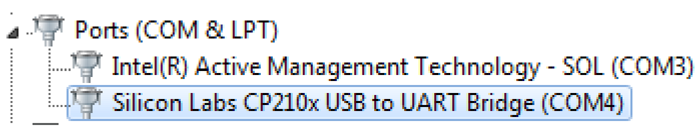
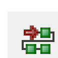


Figure 11 – Find the COM port number for the SiLabs USB-UART device

9. Open a Terminal, such as **Tera Term**, and set the **COM port** to active COM setting for your board and set the **Baud Rate at 115,200**.
10. Program the PL first by clicking the  icon or selecting **Xilinx Tools → Program FPGA**. The default options are acceptable. Click **Program**. When complete, the Blue DONE LED should light.

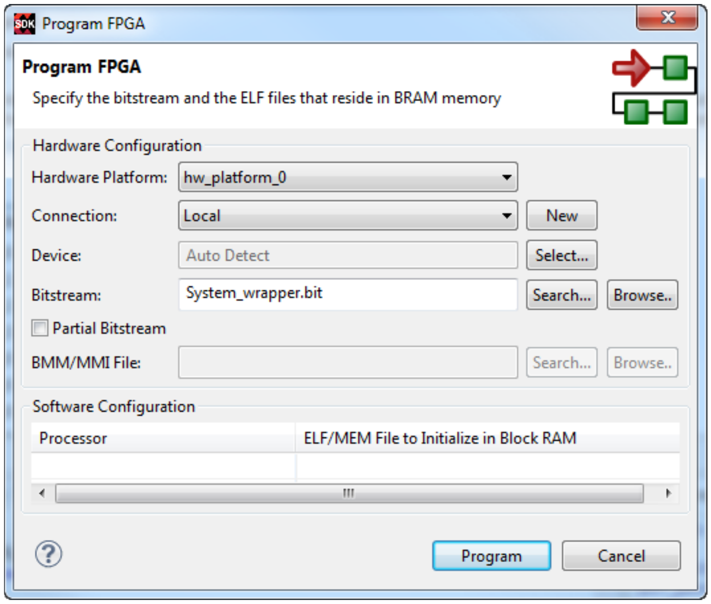


Figure 12 – Program FPGA

Experiment 3: Run Echo Server Application

1. Right-click on the lwIP_Echo_Server_Test application and select **Run As → Launch on Hardware (System Debugger)**.

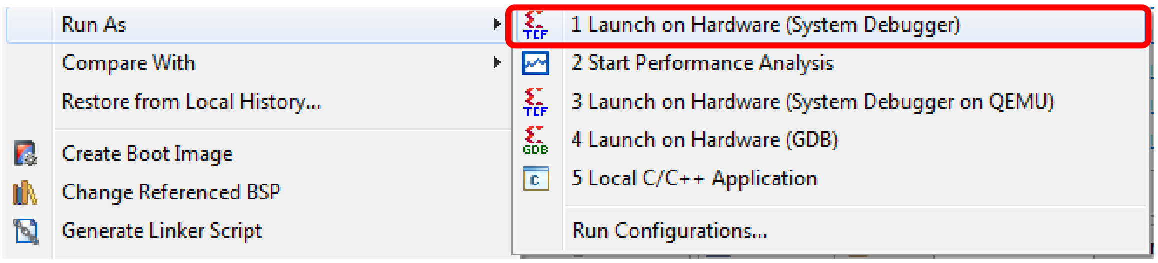


Figure 13 – Launch on Hardware (GDB)

2. The tools will now initialize the processor, download the lwIP_Echo_Server_Test.elf to DDR, and then run lwIP_Echo_Server_Test application. This takes a few seconds to complete, depending on the USB traffic in your system. You can follow the progress in the lower right corner of SDK. You should see something along the following in the Tera Term terminal.

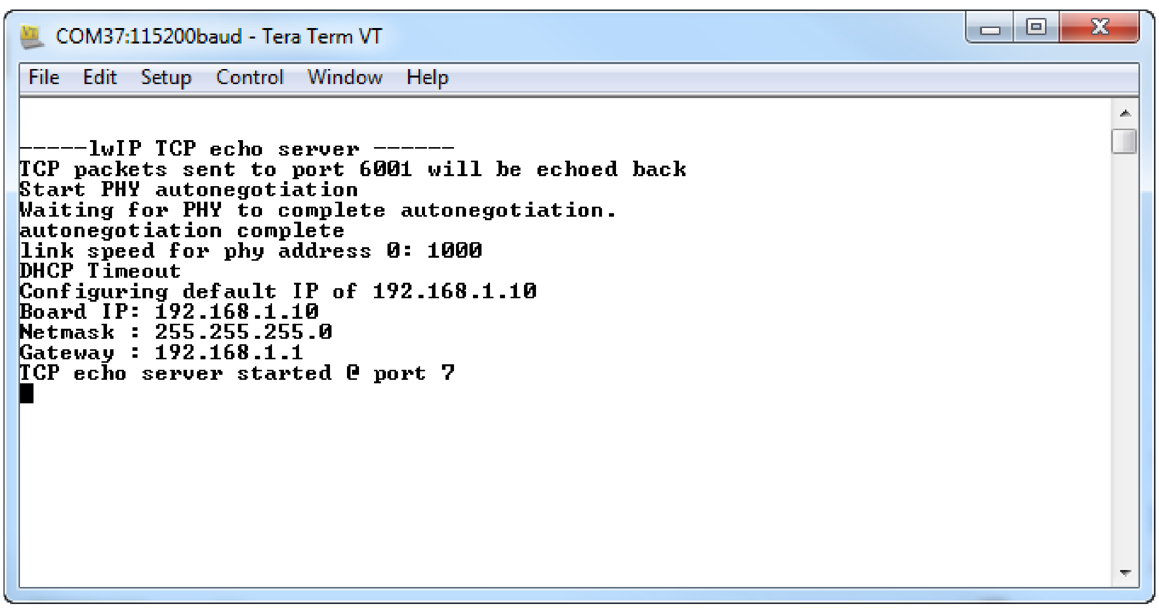


Figure 14 – Launch on Hardware (System Debugger)

3. Open a command window and ping the board as shown below using the **ping <Board IP>** command. If the Ethernet connection is working, you should see 4 replies back as shown

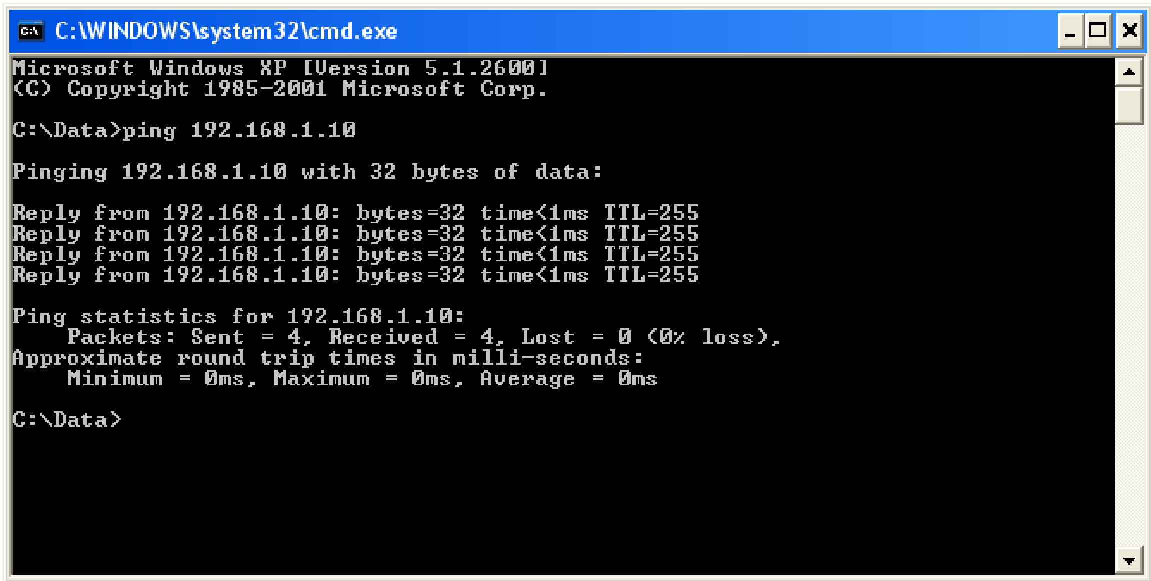


Figure 15 – Windows Command Window

4. To connect to the echo server, use the telnet utility program. Type the following telnet command as shown below in figure 12 and hit the return key.
   telnet <Board IP> 7

If your Telnet Utility Program is not enabled please follow the steps 1-5 below.

1. Click **Start** > **Control Panel**.
2. Click **Programs and Features**.
3. Click **Turn Windows features on or off**.
4. In the **Windows Features** dialog box, check the **Telnet Client** check box.
5. Click **OK**. The system installs the appropriate files. This will take a few seconds to a minute.

You can also install the Telnet Client by using the command line and following these instructions :

1. Open a command prompt window. Click **Start**, type **cmd** in the **Start Search** box, and then press **ENTER**.
2. Type the following command: **`pkgmgr /iu:"TelnetClient"`**
3. If the **User Account Control** dialog box appears, confirm that the action it displays is what you want, and then click **Continue**.
4. When the command prompt appears again, the installation is complete.

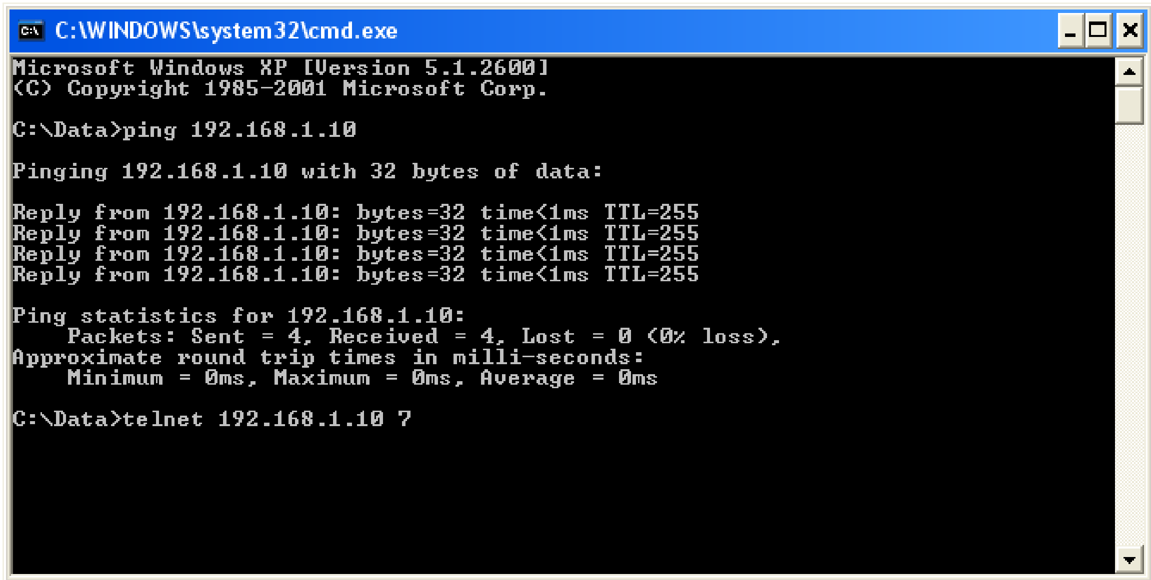


Figure 16 – Launch on Hardware (GDB)

5. If the echo server works properly, any data sent to the board is echoed in response. Some telnet clients immediately send the character to the server and echo the received data back instead of waiting for the carriage return. Simply type a few characters and see them echoed back in the Telnet terminal. After typing, you can quit the telnet session gracefully by typing **<Ctrl key>]** then at the prompt type **quit**.

Revision History

Date	Version	Revision
22 Sept 2016	2016_2.01	Initial Avnet release for Vivado 2016.2