How to Connect the mbed Microcontroller to the Internet

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Purpose of Manual

This manual is specifically designed for use with the mbed NXP LPC1768. The contents of this manual will help you connect your mbed to the Internet via an Ethernet cable mainly by using a protocol called Internet Connection Sharing (ICS).

Introduction

ICS allows a network of computers to connect to the Internet via a single point of connection. Therefore, the host computer acts similarly to a network address translation (NAT) router providing Internet protocol (IP) addresses to all other computers on its network. Therefore, a device on the host computer’s network will be assigned an IP address that is specific to that network. In other words, that device’s IP address will not be directly accessible outside the network without using port forwarding or another service through the host computer.

Operating Systems

These methods for connecting the mbed have been researched and tested to work on the following operating systems:

- Windows 7 Ultimate 64-bit SP1
- Ubuntu version 12.10
- Mac OSX Lion 10.8.1

Many other versions of these operating systems should use similar or exactly the same steps as the ones that will be described later in this manual. There is also a section included specifically for connecting your mbed to a conventional router that does not have reserved ports for certain media access control (MAC) addresses.

Note: The routers that are included in the ECE 4180 lab on the first floor of Van Leer along with many other routers in other labs around campus do have their physical ports reserved for certain MAC addresses.
General Setup

1. For the mbed to properly communicate using the Ethernet jack and Sparkfun breakout board, the connections must be set up properly as shown in Table 1. Different magjacks may use different pins.

2. Make sure to compile and program your mbed. An example program that will be used later and does a simple HTTP GET request over port 80 and is provided at https://mbed.org/users/mkersh3/code/ECE4180EthernetTest/. You can simply import the program to the online compiler, compile the program, and save it the mbed’s flash memory for testing purposes.

<table>
<thead>
<tr>
<th>mbed</th>
<th>Breakout Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD+</td>
<td>P1</td>
</tr>
<tr>
<td>TD-</td>
<td>P2</td>
</tr>
<tr>
<td>RD+</td>
<td>P7</td>
</tr>
<tr>
<td>RD-</td>
<td>P8</td>
</tr>
</tbody>
</table>

Table 1 Ethernet wiring chart for mbed ports

Layout

Each operating system section will be split into two different subsections labeled “Internet Connection” and “Terminal Connection”. Each “Internet Connection” subsection will give you step-by-step instructions with screen shots on how to set up ICS. The “Terminal Connection” section, on the other hand, will provide step-by-step instructions with screen shots on how to set up a terminal screen to view and send information over the mbed’s virtual COM port. This “Terminal Connection” section will also be useful for other labs when trying to set up a virtual COM port connection with the mbed in other scenarios that are not Internet connection, so make sure to keep this guide or remember the steps for your respective operating system. For Windows computers, a program called TeraTerm which is available free for downloading at http://en.sourceforge.jp/projects/ttssh2/releases/ will be used. In both Ubuntu and Mac, an application called “screen” will be used to make connections to the virtual COM port on the mbed. The application should be built into Mac upon install. However, Ubuntu may not come with “screen” preinstalled. If you get any errors regarding not having “screen” installed on your Ubuntu build, run the following line of code in any open terminal to install it and use for future communications.

```
sudo apt-get install screen
```
Assumptions

For the remainder of this manual, there will be certain assumptions made about your system that will be outlined here.

1. **Functional Wireless Connection:** For the sections regarding the configuration of ICS for use within a given operating system, it will be assumed that you already have a functional wireless connection set up and operational with your Internet provider. For more information on how to connect to the Georgia Tech wireless network specifically, please visit [http://lawn.gatech.edu/](http://lawn.gatech.edu/).

2. **Functional Ethernet Port:** If you plan to use ICS within your operating system, a working Ethernet port must be installed on your host machine in order to transfer Internet packets to and from the mbed.

3. **Virtual COM Port Setup:** If the Windows operating system is being used, the mbed’s virtual COM port driver must be installed in order to connect to the mbed’s virtual COM port.

4. **Virtual COM Port Application:** In all operating systems, your virtual COM port communication software, whether that is “TeraTerm” for Windows or “screen” for Mac or Ubuntu, must be installed and operational before use with the mbed.

5. **Virtual COM Port Permissions:** As the user of your computer, you must also have sufficient permissions to use the COM port on the mbed. These rights are given to Windows users upon installing the virtual COM port drivers. Generally this is not a problem in Ubuntu and Mac, but below is the following line of code that must be run in order to provide the correct permissions in case they are not inherently provided for you.

   ```bash
   sudo chmod 777 [insert COM port address here]
   ```

   The “Terminal” subsections of the Ubuntu and Mac operating system sections will go over how to find the COM port address. Also, do NOT type the brackets when executing the previous line of code.
How to Install Using Windows

Internet Connection

1. Click on the Internet connection icon near the bottom-right hand corner of your screen and click on the “Open Network and Sharing Center” button that is outlined in red as shown in Figure 1.

2. Next click the “Change adapter settings” option as shown on the left side of Figure 2.

3. Right-click on the “Wireless Network Connection” adapter and choose “Properties”.

Figure 1 Internet Connection Window

Figure 2 Network and Sharing Center

Figure 3 Adapter List Dialog Box
4. Next click on the “Sharing” tab on the properties window that appears.
5. Check the top box that states “Allow other network users to connect through this computer’s Internet connection”.
6. Now choose “Local Area Connection” from the drop-down menu that appears.
7. Click the “Settings…” button and choose which services you would like to allow your mbed to use.

![Figure 4 Wireless Adapter Properties Window](image)

**Note:** The “Web Server (HTTP)” option must be checked in order to run the sample code that accesses the mbed website.

8. Click the “OK” buttons on the “Advanced Settings” and adapter properties windows and close the adapter list dialog box shown in Figure 3 to finalize the Windows ICS setup.

### Terminal Connection

1. Make sure your mbed is connected to your Windows machine via the USB and Ethernet connections and that the correct test code has been programmed onto it.
2. Open the TeraTerm program and choose the correct COM port on which your mbed is located.
3. Once the screen has been successfully opened, press the reset button on the mbed and wait for the code to run. A sample TeraTerm window of the output can be seen in Figure 5.

![Figure 5 Sample program run through TeraTerm to establish Internet connection and display “Hello world!”](image)

**Note:** Be patient. The mbed may take up to a minute to make a successful connection and ping the mbed servers.
How to Install Using Ubuntu

Internet Connection

1. Click on the Internet connection icon near the top-right hand corner of your screen and click on the “Edit Connections” button to open the window shown in Figure 6.

2. Under the “Wired” tab, click the “Edit…” button located on the right side of the window.

3. Click the “IPv4 Settings” tab and change the method to “Shared to other computers”.

4. Save the connection settings and close the network connections dialog box.

Figure 6 Network Connections Dialog Box

Figure 7 Adapter Settings Dialog Box
Terminal Connection

1. Open a terminal window if one is not open already by pressing Ctrl + Alt + T and enter the following command

   \texttt{dmesg}

   as shown in Figure 8. This will list all connections that have been made to the computer since the last time the command was run.

2. Connect the mbed and run the \texttt{dmesg} command again to view the mbed as the most recent connection and note the COM port address outlined in red within Figure 9. The port address will likely take the form of \texttt{"ttyACMX"} where \texttt{X} can vary over all possible COM port numbers.

3. Next run the command

   \texttt{cd ~/../../dev}

   to navigate to the devices folder where the COM port connection is located.

4. Then run the command

   \texttt{screen –U ttyACMX}

   to open a screen using Unicode characters at the previously noted COM address location. If you receive any errors about read/write permissions when executing the screen command, read point “5.” in the “Assumptions” section and redo this step.

5. Once the screen has been successfully opened, press the reset

   \texttt{Figure 10} Sample program run through screen to establish Internet connection and display “Hello world!”

\textbf{Note:} Before starting this subsection, disconnect the USB port on the mbed to ease finding the COM port number.
button on the mbed and wait for the code to run. A sample screen window of the output can be seen in Figure 10.

**Note:** Be patient. The mbed may take up to a minute to make a successful connection and ping the mbed servers.

6. In order to leave the screen and return to the terminal, type the following keystrokes:

\[ \text{Ctrl} + \text{A} \rightarrow \text{K} \rightarrow \text{Y}. \]

**How to Install Using Mac OSX**

**Internet Connection**

1. Click the Apple icon in the upper-left hand corner of the desktop and open the “System Preferences…” section outlined in red as shown in Figure 11.
2. Click the “Sharing” icon as outlined in Figure 12.

3. In the window that appears, click on “Internet Sharing”. Choose “Wi-Fi” from the “Share your connection from:” drop-down menu and check the Ethernet box.

4. Next check the “Internet Sharing” box and press start on the dialog box that drops down from the top of the “Sharing” window seen in Figure 13.

Terminal Connection

1. Click on the “Spotlight” icon in the top-right hand corner of your desktop and search for the “System Information” application which will be used to find the mbed’s COM address.

**Note:** Connect your mbed’s USB cable before proceeding with the following steps.
2. In the window that appears, click on the “USB” line under the “Hardware” section and “Microcontroller” in the “USB” section. Note the “Location ID:” as outlined in Figure 15.

3. The “Location ID:” number there will form the COM address in the following manner:
   a. The number located after the forward slash will be appended to the most significant digits of the hexadecimal number.
   b. This number will then be appended to the end of the letters “tty.usbmodem”
   c. For example, the ID in Figure 15 will form the COM port address of “tty.usbmodem3a22”

4. Once you have completed the previous step to find your COM port address, open a terminal window. Figure 16 uses the same process as in step 1 to open a terminal window.

5. When the terminal has been opened, run the following command to navigate to the correct folder where you COM port connection is located:

   ```
   cd ~/../../dev
   ```

6. At this point, you may run the “ls” command to ensure that the COM port address that you found in step 3 is correct and present.
7. Next, run the following command to open the screen application:

    `screen –U tty.usbmodemX`

where X is the number found in step 3a in order to open a screen using Unicode characters. The COM port address is outlined as seen in Figure 17.

8. In order to leave the screen and return to the terminal, type the following keystrokes:

    `Ctrl + A → K → Y`.

9. Once the screen has been successfully opened, press the reset button on the mbed and wait for the code to run. A sample screen window of the output can be seen in Figure 18.

    **Note:** Be patient. The mbed may take up to a minute to make a successful connection and ping the mbed servers.
How to Install Using a Router

Internet Connection

1. Connect the router to the Internet as specified through your owner’s manual. Refer to http://resnet.gatech.edu/internet/wired/Pages/multipleDevices.aspx for more information on connecting routers to the Georgia Tech network.

2. Attach your Ethernet cable to the mbed and any of the open client ports available on the back of the router.

Terminal Connection

1. Refer to the “Terminal Connection” section that is specific to your particular operating system and follow the directions there.