

How to Connect the mbed Microcontroller to the Internet

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4/5/2013

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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.

mbed	Breakout Board
TD+	P1
TD-	P2
RD+	P7
RD-	P8

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/tssh2/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/>.
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.

```
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.



Figure 1 Internet Connection Window

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

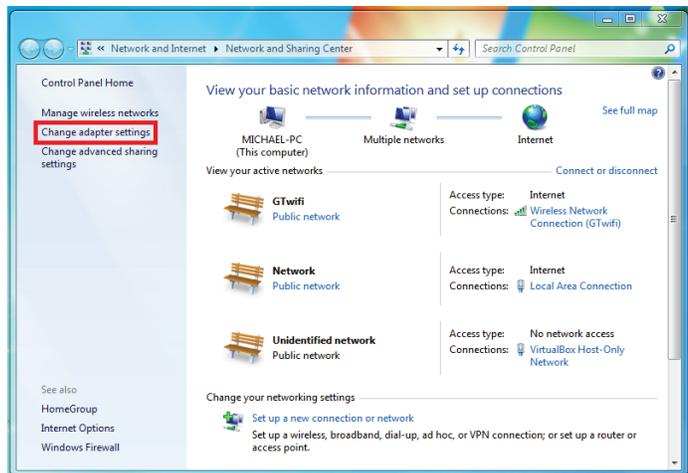


Figure 2 Network and Sharing Center

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

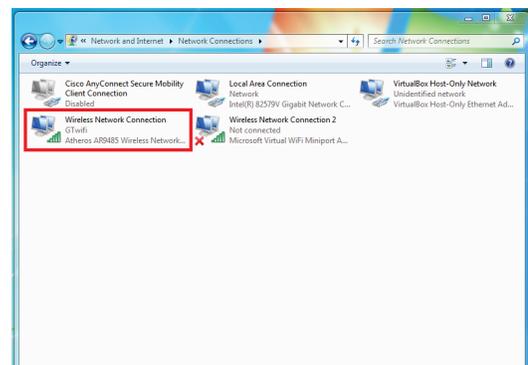


Figure 3 Adapter List Dialog Box

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

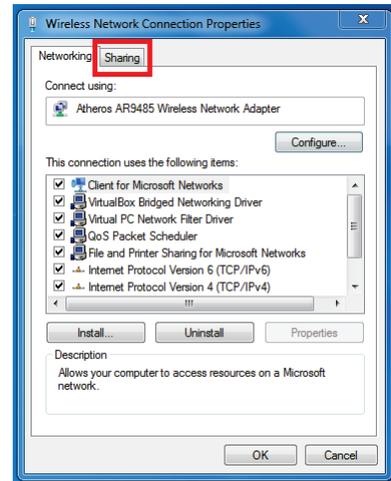


Figure 4 Wireless Adapter Properties Window

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

- 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

- 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.
- Open the TeraTerm program and choose the correct COM port on which your mbed is located.
- 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.

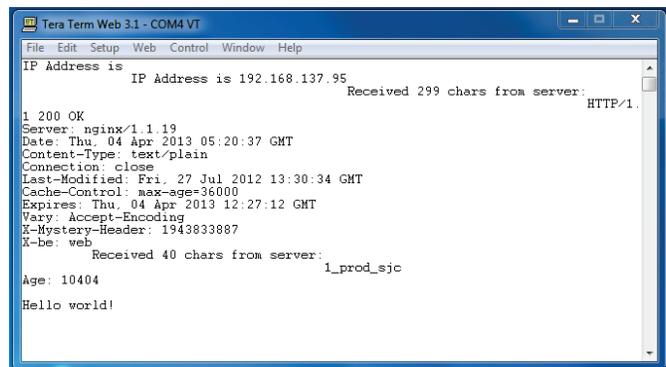


Figure 5 Sample program run through TeraTerm to establish Internet connection and display “Hello world!”

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.

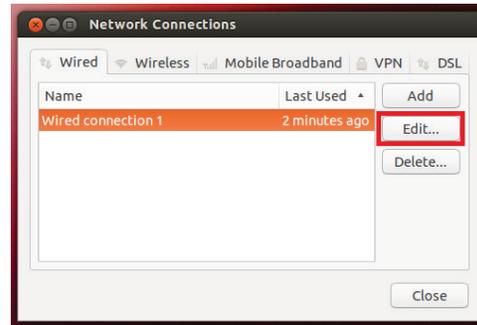


Figure 6 Network Connections Dialog Box

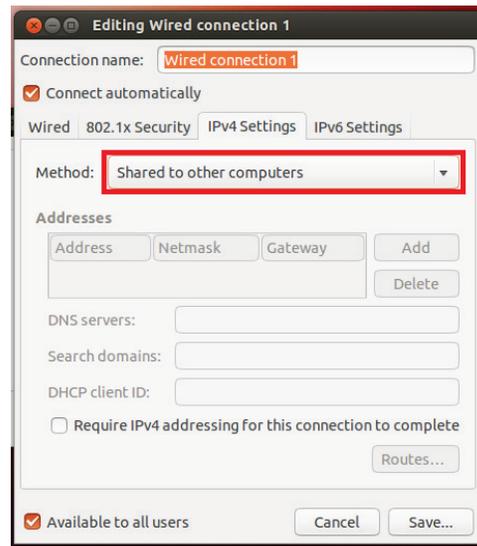


Figure 7 Adapter Settings Dialog Box

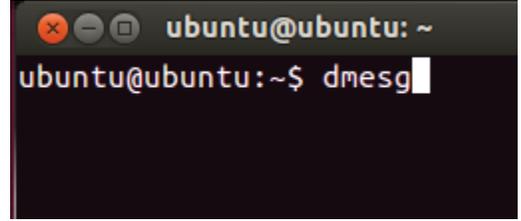
Terminal Connection

Note: Before starting this subsection, disconnect the USB port on the mbed to ease finding the COM port number.

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

`dmesg`

as shown in Figure 8. This will list all connections that



```
ubuntu@ubuntu: ~  
ubuntu@ubuntu:~$ dmesg
```

Figure 8 “dmesg” Command in Terminal

have been made to the computer since the last time the command was run.

2. Connect the mbed and run the `dmesg` command

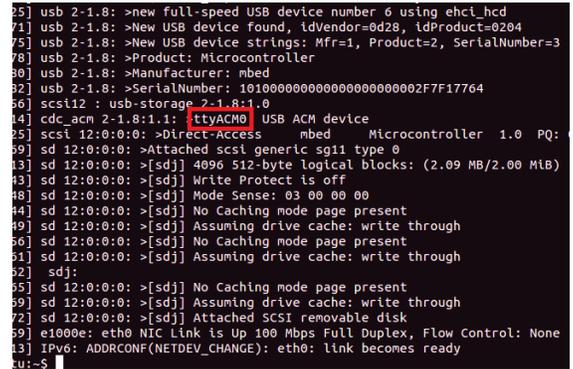
again to view the mbed as the most recent

connection and note the COM port address outlined

in red within Figure 9. The port address will likely

take the form of “`ttyACMX`” where X can vary over

all possible COM port numbers.



```
25] usb 2-1.8: >new full-speed USB device number 6 using ehci_hcd  
71] usb 2-1.8: >New USB device found, idVendor=0d28, idProduct=0204  
75] usb 2-1.8: >New USB device strings: Mfr=1, Product=2, SerialNumber=3  
78] usb 2-1.8: >Product: Microcontroller  
80] usb 2-1.8: >Manufacturer: mbed  
82] usb 2-1.8: >SerialNumber: 1010000000000000000002F7F17764  
86] scsi12 : usb-storage 2-1.8:1.0  
14] cdc_acm 2-1.8:1.1: ttyACM0 USB ACM device  
25] scsi 12:0:0:0: >Direct-Access mbed Microcontroller 1.0 PQ:  
29] sd 12:0:0:0: >Attached scsi generic sg11 type 0  
43] sd 12:0:0:0: >[sdj] 4096 512-byte logical blocks: (2.09 MB/2.00 MiB)  
43] sd 12:0:0:0: >[sdj] Write Protect is off  
48] sd 12:0:0:0: >[sdj] Mode Sense: 03 00 00 00  
44] sd 12:0:0:0: >[sdj] No Caching mode page present  
49] sd 12:0:0:0: >[sdj] Assuming drive cache: write through  
56] sd 12:0:0:0: >[sdj] No Caching mode page present  
51] sd 12:0:0:0: >[sdj] Assuming drive cache: write through  
52] sdj:  
55] sd 12:0:0:0: >[sdj] No Caching mode page present  
59] sd 12:0:0:0: >[sdj] Assuming drive cache: write through  
72] sd 12:0:0:0: >[sdj] Attached SCSI removable disk  
59] e1000e: eth0 NIC Link is Up 100 Mbps Full Duplex, Flow Control: None  
13] IPv6: ADDRCONF(NETDEV_CHANGE): eth0: Link becomes ready  
su:~$
```

Figure 9 “dmesg” Command Output in Terminal

3. Next run the command

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

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

4. Then run the command

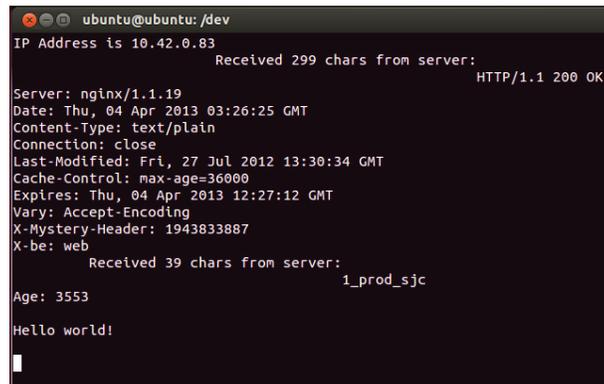
`screen -U ttyACMX`

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



```
ubuntu@ubuntu: /dev  
IP Address is 10.42.0.83  
Received 299 chars from server: HTTP/1.1 200 OK  
Server: nginx/1.1.19  
Date: Thu, 04 Apr 2013 03:26:25 GMT  
Content-Type: text/plain  
Connection: close  
Last-Modified: Fri, 27 Jul 2012 13:30:34 GMT  
Cache-Control: max-age=36000  
Expires: Thu, 04 Apr 2013 12:27:12 GMT  
Vary: Accept-Encoding  
X-Mystery-Header: 1943833887  
X-be: web  
Received 39 chars from server: 1_prod_sjc  
Age: 3553  
Hello world!
```

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

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:

Ctrl + A → K → 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.

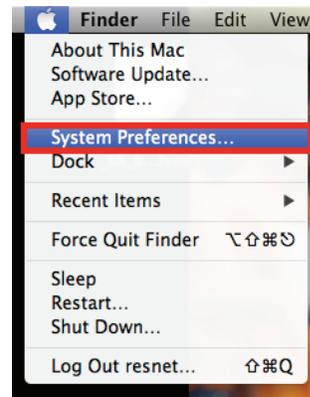


Figure 11 System Preferences Button in Menu

2. Click the “Sharing” icon as outlined in Figure 12.



Figure 12 System Preferences Window

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.

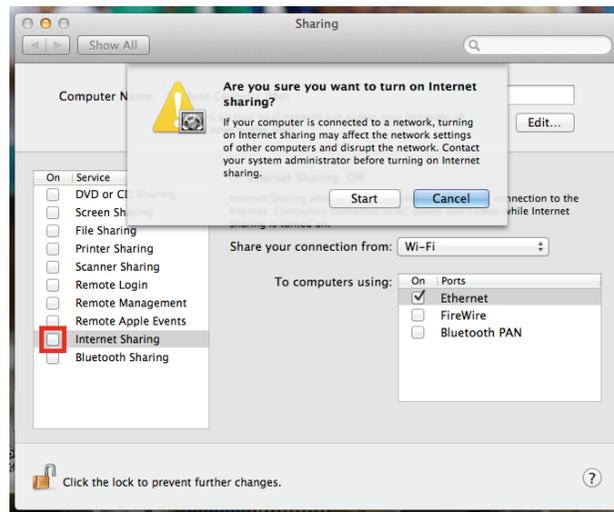


Figure 13 Sharing Window

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.

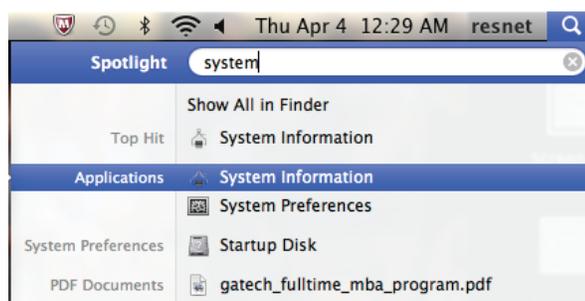


Figure 14 “Spotlight” Search for the “System Information” Application

2. In the window that appears, click on the “USB” line under the “Hardware” section and the “USB” line under the “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.

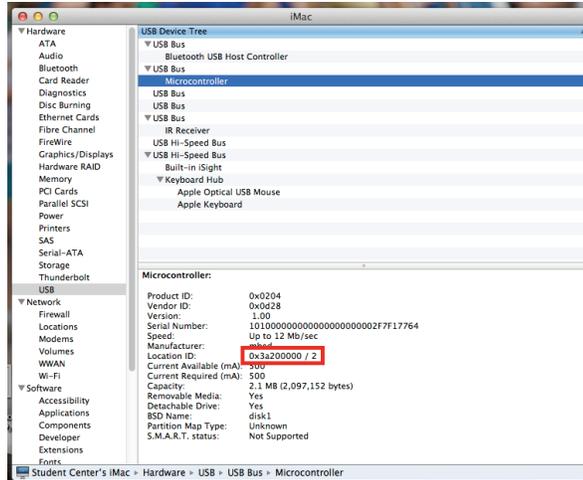


Figure 15 System Information for mbed

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.

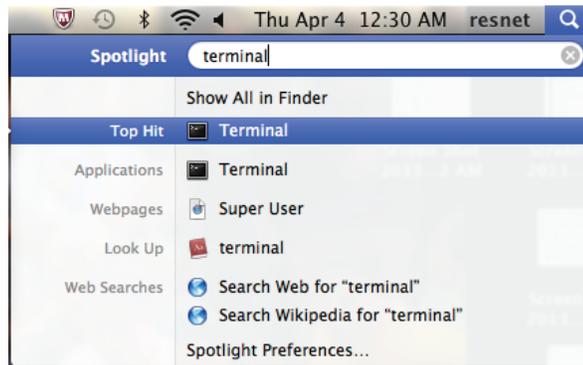


Figure 16 “Spotlight” Search for the “Terminal” Application

- 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.

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

Ctrl + A → K → Y.

```

Last login: Thu Apr  4 00:30:58 on ttys000
lawn-143-215-105-79:~ resnet$ cd ~/../../dev
lawn-143-215-105-79:dev resnet$ ls
afsc_type5          ptyp3              ptyrb              ptyu3              ptywb
auditpipe           ptyp4              ptyrc              ptyu4              ptywc
auditsessions      ptyp5              ptyrd              ptyu5              ptywd
autofs              ptyp6              ptyre              ptyu6              ptywe
autofs_control      ptyp7              ptyrf              ptyu7              ptywf
autofs_homedirmounter ptyp8              ptyrs0             ptyu8              random
autofs_notrigger    ptyp9              ptyrs1             ptyu9              rdisk0
autofs_nowait       ptypa              ptyrs2             ptyua              rdisk0s1
bpf0                ptypb              ptyrs3             ptyub              rdisk0s2
bpf1                ptypc              ptyrs4             ptyuc              rdisk0s3
bpf2                ptypd              ptyrs5             ptyud              rdisk1
bpf3                ptype              ptyrs6             ptyue              sdt
console             ptypf              ptyrs7             ptyuf              stderr
cu.Bluetooth-Modem ptyq0              ptyrs8             ptyv0              stdin
cu.Bluetooth-PDA-Sync ptyq1              ptyrs9             ptyv1              stdout
cu.usbmodem3a22     ptyq2              ptyrsa             ptyv2              systrace
disk0                ptyq3              ptyrsb             ptyv3              tty
disk0s1              ptyq4              ptyrsc             ptyv4              tty.Bluetooth-Modem
disk0s2              ptyq5              ptyrsd             ptyv5              tty.Bluetooth-PDA-Sync
disk0s3              ptyq6              ptyrse             ptyv6              tty.usbmodem3a22
disk1                ptyq7              ptyrsf             ptyv7              ttyu0
dtrace              ptyq8              ptyrt0             ptyv8              ttyu1
dtracehelper        ptyq9              ptyrt1             ptyv9              ttyu2
fbt                  ptyqa              ptyrt2             ptyva              ttyu3
fd                   ptyqb              ptyrt3             ptyvb              ttyu4
fsevents            ptyqc              ptyrt4             ptyvc              ttyu5
io8log              ptyqd              ptyrt5             ptyvd              ttyu6
io8logmt            ptyqe              ptyrt6             ptyve              ttyu7
klog                 ptyqf              ptyrt7             ptyvf              ttyu8
lockstat            ptyr0              ptyrt8             ptyw0              ttyu9
machtrace           ptyr1              ptyrt9             ptyw1              ttypa
null                 ptyr2              ptyta              ptyw2              ttypb
pf                   ptyr3              ptytb              ptyw3              ttypc
pfm                  ptyr4              ptytc              ptyw4              ttypd
pmCPU               ptyr5              ptytd              ptyw5              ttype
profile             ptyr6              ptyte              ptyw6              ttypf
ptmx                ptyr7              ptytf              ptyw7              ttyq0
ptyp0               ptyr8              ptyu0              ptyw8              ttyq1
ptyp1               ptyr9              ptyu1              ptyw9              ttyq2
ptyp2               ptyra              ptyu2              ptywa              ttyq3
lawn-143-215-105-79:dev resnet$ screen -U tty.usbmodem3a22

```

Figure 17 Terminal window showing commands run

- 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.

```

IP Address is 192.168.2.2
Received 299 chars from server: HTTP/1.1 200 OK
Server: nginx/1.1.19
Date: Thu, 04 Apr 2013 04:33:33 GMT
Content-Type: text/plain
Connection: close
Last-Modified: Fri, 27 Jul 2012 13:30:34 GMT
Cache-Control: max-age=36000
Expires: Thu, 04 Apr 2013 12:27:12 GMT
Vary: Accept-Encoding
X-Mystery-Header: 1943833887
X-be: web
Received 39 chars from server: 1_prod_sjc
Age: 7581
Hello world!

```

Figure 18 Sample program run through screen to establish Internet connection and display “Hello world!”

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.