

# Empowering Freshmen with Technology Skills: Wireless Routers

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## Abstract

Most freshmen taking required, introductory information systems courses do not understand why they are required to take such courses and can't imagine that they will learn anything they don't already know. This paper presents an exercise that will excite and enthuse students about their computers and Information Systems in general. Every freshman is familiar with wireless network connections having used them with both their computers and their phones. The setup of those wireless networks however is somewhat of a mystery and considered far too complex to deal with by most students. This paper outlines a strategy for demystifying the technology and involving students in hands-on learning. By actually setting up a wireless router students gain confidence in their computer skills and become interested in learning more about information systems. This paper describes the process used to gain their interest and includes a handbook that can be used with students everywhere.

**Keywords:** wireless networks, routers, TCP/IP, teaching the introductory course

## 1. INTRODUCTION

As technology becomes more and more part of our world many schools like Bentley require students to take an introductory course in information systems. In most cases there is no assessment of the student's technology skills so that a typical class has a broad range of ability, interest, and technology skills among the students. Students typically do not want to take these required courses because they often do not have an interest in technology. Their world has always included computers and most believe they know enough from high school or personal experience to succeed in both their personal and professional lives. As teachers we are faced with the difficulty of even getting their attention no less motivating them to learn the fundamentals of our discipline, information systems.

Most students, although they know little of how networks operate, are very interested in being connected. Their experience with wireless networks is a mix of success and failure.

1. They love to be connected and as cost conscience consumers are always looking for a "free" connection that will not impact the cell phone bill.
2. Speed is very important to them and often a Wi-Fi connection is much faster than their cell carrier's data connection.
3. Although most understand the concept of a wireless password to get on a particular network, many have been frustrated by failure to connect even with the correct password.
4. Streaming (music or video) is an important part of their lives. Lack of knowledge often leads to more frustration as videos pixilate or refuse to play.

This paper presents one way to awaken student's attention and capture their interest. Most students find this a fun and empowering exercise that can change their view of information systems. Some have even pointed

to it as the reason they started thinking about selecting information systems as their major.

Bentley University has one of the longest running portable computer programs in the country. All students have been required to have a school supplied laptop computer running Microsoft Windows since 1984. The author has approached this paper with the assumption that most students have access to a portable computer for the introductory course and likely have some form of smart phone. The instructions are written for the Microsoft Windows environment but can easily be changed to accommodate Apple machines. Students are broken into groups of three or four and each group must have at least one laptop and one smart phone among the three or four devices in the group. Although the exercise can be done with three laptops, using a smart phone as one of the devices is a real plus from the student perspective. A physical router is also required for each group. Although it is easier for the instructor if all the routers are identical, a variety of routers could be used with the understanding that each manufacturer builds their menus a little differently. This exercise was so successful we currently use it in all sections of our introductory course and continue to receive very positive feedback from students about it.

The paper presents the material in the form of a handbook. The *IT101 Wireless Router Lab* gives students a step by step instruction set for building a wireless network. There are 20 questions included in the handbook and we use the answers to the questions as proof of learning. As you will see in the handbook we introduce students to on-line collaboration by requiring the document to be done in the form of a Google Doc. This gives the instructor the ability to see which student has done what questions through the revision history. An actual copy of the current handbook is located in the appendices.

## 2. IT101 WIRELESS ROUTER LAB

This lab exercise is designed to allow your students to learn to create a wireless network, and connect computers to it both with and without encryption and interact with networking tools in the Windows operating system. There is an actual copy of the document we give students in the appendices of this paper. There is also an instructor's guide with specifics for instructors running the Lab in the appendices. The Lab is

best done in groups of 3 students but can be done with 4.

### ***What they need to know before starting***

How to connect your computer to a wireless network

How to use a web browser

How to determine a computer or mobile device's MAC address and IP Address

How to recognize a router, and what a router does

How to use Google Docs to create, edit, and share a document

How to take a screen shot on your computer and mobile device

### ***Required Hardware***

1 Wireless Router

1 computer equipped with wireless networking capabilities

1 mobile device equipped with wireless networking capabilities

1 computer equipped with an Ethernet adaptor (any wireless should be turned off)

2 Ethernet cables

1 USB flash drive

1 wired Internet connection

### ***Software***

Windows 7 on at least one laptop (other operating systems work but the directions are different from what is presented here.) If you have a computer that is not running Windows 7 in a group, please use it for computer #1 since that machine is only using a browser.

A Web browser (Internet Explorer, Firefox, Safari, Chrome, etc. all work equally well)

Gmail accounts for all group members

### ***Lab Report***

Each group will collaborate to complete a lab report as a Google Doc containing several screen shots and answers to questions that appear within the instructions. Have the students decide which questions each person will work on for the lab report. In many cases they will be creating screen shots or taking digital photographs. Have them take notes as they do the Lab and upload the notes and images to the Google Doc either as they go along, or shortly after they complete the exercise. They should NOT write their part of the lab report in Microsoft Word and paste it into Google Docs all at once. Each member of the group should contribute to the Lab report. The instructor can identify what was added to the Google Document by each

member of the group using the Revision History tool. Note that they cannot take too many screen shots.

### **Group members and roles**

There should be three people in each group, each managing a different device. The roles are:

Role #1: This person is responsible for configuring the router using a personal computer.

Role #2: This person will connect a personal computer wirelessly to the network. There should not be ANY Ethernet cables connected to this computer.

Role #3: This person will connect a mobile device (smart phone or tablet) wirelessly to the network.

### **Create a wireless network!**

Start by having one person in each group create a Google Doc for the group's lab report, and invite the other group members and the instructor as collaborators. They will need the Google ID's for each person in the group, and the instructor. All group members should open Google Drive and access the lab report document so that each person can edit it at the same time as they complete the exercise.

Have them completely power down Computer #1 (the "wired" machine, to which they will connect the router with an Ethernet cable).

Have them identify the ports on the back of the router. There should be 4 LAN ports (black interiors), one WAN port (yellow interior) and possibly one USB port.

Connect the wired computer (Computer #1) to the router making sure the cable connects to one of the 4 LAN ports (black ports).

Connect the WAN port (yellow port) on the router to a working Internet connection using an Ethernet cable.

Power up the router by plugging the power brick into an outlet and the router. If nothing happens look for a power button on the router.

There are LED lights on the front of the router to give you the status of the router. Watch the icons on the router as it boots.

When lights are lit on the router power up the wire connected computer and log into Windows.

### **Configure the router on the wired computer**

Every router has a set of default settings that can be looked up on the Internet. These include a default address, a user name and a password. It is best to look these up and have them ready for the students.

Have them connect to the router's built-in Web page by placing the router's default address into a Web browser on the wired computer. Once they have connected to the router's Web page the rest is just a matter of navigating through the router's menus making changes and testing the changes.

The first change you want them to make is to set a new administrative password. Challenge them to use their knowledge of good passwords to come up with a group password that will keep their router settings safe from the other groups in the room.

### **Set the SSID for the Network on the router**

Next have each group select an SSID for their network. We had some trouble with groups selecting inappropriate names so we now give them some guidance with this instruction: "Create an SSID for your group by using the first three letters of the first name of each person in your group. (For example, bilmardou for Bill, Mark, Doug). Use this nine-character string as the SSID. Type it in entirely in lower case. NOTE: The SSID is case sensitive just like a password.

### **Connect a computer or mobile device to your wireless network**

Most students are familiar with connecting both computers and mobile devices to unprotected wireless networks so this step should be easy.

**In Windows 7, the first time you connect to a network, sometimes you are asked to classify its location type as home, work, or public. When you are connected to a public location, Windows 7, if told it is a public location, disables all network and sharing to protect your information. You can change what kind of connection it is at any time by modifying the settings for that connection. In this Lab the students are building the equivalent of a work network and should identify as such if asked. Windows may not display the Set Network Location dialog box immediately. They can continue with the exercise regardless of whether or not they set the network's location.**

**Connecting a mobile device may require them to go out to the Internet on a connected computer to look up how to do it on their particular device. Have them make sure that they are connected to the correct network and that they have Internet access.**

### **Find the IP and MAC addresses of your computer and mobile device**

Most students are not familiar with these addresses and the number of different connections on some laptops can make this really confusing. This is an opportunity to familiarize the students with the Command Prompt window in Windows and to discover where these addresses are listed on their mobile device. The general instructions for finding these addresses are:

Your computer or mobile device's IP address consists of 4 numbers separated by periods. It may also be called the IPv4 address. If your device has an IP address it verifies that it is connected to a network. The MAC address (sometimes called the *physical address*) consists of 6 sets of two digits separated by dashes or colons. It is a number that uniquely identifies your device. To find this information in Windows:

Click the Start button in the lower left corner and select "All Programs".

Select "Accessories" and then "Command Prompt".

In the command window, type `ipconfig /all` and press <ENTER>. (make sure there is a space between `ipconfig` and the `/`). Issuing the `ipconfig /all` command generates several screens of information. Many computers have several MAC or physical addresses associated with it, so make sure you are looking at the correct one for your machine's connection. When looking at the results of the `ipconfig /all` command, Computer #1's IP address (IPv4) and physical (MAC) address are located under *Ethernet adapter Local Area Connection*. Computer #2's IP address is located under *Wireless LAN Adapter Wireless Network Connection*. To find your IP and MAC address on your mobile device:

On an iOS device, from the Settings app, tap Wifi, locate the network to which you're connected, and tap the arrow near the network

name to reveal the IP address. Tap Settings, General, About to find your MAC address.

On an Android device, tap Settings, Device Settings, Status to view your IP and MAC addresses

Use a search engine to find more detailed instructions to find your IP or MAC address on your device if necessary.

### **See which devices are connected to the network**

An important tool for checking on connections is the Attached Devices List (it may have a different name depending upon the router). The Attached Devices list (on the router menu) identifies the computers connected to the router by their IP addresses (and specifies whether they are connected via a wired or wireless connection). On the wired computer, click the menu choice Attached Devices on the router's menu list to see a list of what computers are connected to it. Remind students that they can use the Attached Devices menu choice on the router at any time to check and see who is actually connected to their router. Important note: You cannot see MAC addresses or IP addresses for other computers in the black Windows Command Prompt box. Only that computer's information will show there. The router sees all of the computers and the Attached Devices menu option on the router will show everyone attached to that router.

### **Stop broadcasting the network's SSID**

The next security step is to turn off the broadcast of the SSID. When this is done the name of the network no longer shows up on the list of available networks unless a setting has been added. The box to broadcast or not is usually on the wireless settings screen on the router. This will disconnect the wireless devices and wireless laptops from the network. This is the first spot where students who are not careful can run into a large amount of frustration trying to get reconnected. There seems to always be one group that makes the wrong change and shuts off wireless altogether. Here are the instructions we use to get the laptops back on:

Left-click the wireless icon in the bottom right-corner of the task bar to see a list of available networks and indicate if you are connected to any of them. (If you are connected to another network please click disconnect)

At the bottom; click on "Open Network and Sharing Center".

On the left side of the Network and Sharing Center screen click on "Manage Wireless Networks". You should see your network on the list.

If your network is on the list, right click it and click properties. You will get a list of three check-off boxes for Auto Connect, Preferred Network and "Connect even if the network is not broadcasting its name". You should check the first and last ones but not the middle one. Also note the Security tab which you will be coming back to when we do the security part of this exercise.

If not click "add" at the top, click "Manually create a network profile" and add the information about your network. You are required to select a security choice and at this point you have none so select the "open" option. Note the check box for automatic start (if checked your computer will automatically connect if it sees this network) and the one for "Connect even if the network is not broadcasting" which needs to be checked if you want to see your network when the router is not broadcasting the SSID. Click next and then close.

Note: You may find that your computer has added a 2 next to the SSID on your computer. The SSID has not changed, the 2 is not part of the name. This is how Windows avoids confusion if an SSID has been added to the list when there is already one there with that SSID. You can always delete the old one.

To connect your mobile device to a network with a hidden SSID:

On an iOS device, tap Settings / WiFi Networks / Other, and enter the network information.

On an Android device, tap Settings, Wi-Fi, Add Wi-Fi network, and enter the network information.

Use a search engine to find more detailed instructions to find your IP or MAC address on your device if necessary. After they have completed one of the two options above they should get their network on the list of available networks and they should be able to connect. Have them verify that they are connected. If they cannot connect, the settings for that network do not match the settings for the

network on the router. The settings must match for the computer or mobile device to connect.

### **Add encryption to the network**

Encrypting the network traffic is a very important step for the students to understand. Many do not realize that with an unprotected network (coffee shops, airports, etc.) everything they type in travels through the air in plain text. Almost anyone can capture and look at whatever passwords are being sent. Encryption has changed over the years and the age of a particular device determines which of the standard three types found on most routers can be done by the device. WEP is the oldest and the weakest. We recommend using WPA2 which is the newest although it has also been broken. Older routers require a hex string but most modern routers will take a word, phrase or hex string. Have them turn on the encryption (which will disconnect the wireless folks again) and build a passphrase to allow the wireless devices to reconnect. The important thing to emphasize here is that whatever security is set on the router must be matched exactly on the device trying to connect. They already have the skills in Windows from the previous section to change the security setting on a Windows machine. Fortunately most other devices make it even easier to connect by self-discovering the security settings and just requiring the passphrase to connect. We tell them:

"Refresh your list of wireless networks on the wireless device. Choose your SSID from the list. When you do, it will prompt you for the key (passphrase) and you must type it in correctly. Remember, the key is case sensitive! If you have trouble connecting use the same process you used earlier to modify each wireless device's settings for your network. You will need to add the encryption settings on the Security tab of the Properties window for your SSID. Again, if the settings on your computer match the settings on the router you will connect. If the settings do not match there is no way you can connect. Note: If neither computer can connect to the network, reconfigure the router using computer #1 to broadcast its SSID. See if that helps. Make sure that on computers 2 & 3, Security Type is set to WPA2-Personal and that Encryption Type is set to AES. The passphrase is case sensitive so make sure that is correct too!"

### **Allow network access based on MAC address**

This section is where students seem to have more trouble than anywhere else. Almost all

routers have the ability to filter connections based upon MAC address. When a device wants to connect the router goes to its list of valid MAC addresses and will only let devices on the list connect. This involves building the list turning the filtering on. It will most likely be located in the router menus under advanced wireless settings or advanced security. The hard part on laptops is finding the correct MAC address. Phones and tablets generally only have one MAC address making it somewhat easier. If they were careful in the section about finding the addresses and wrote them down correctly they should have an easy time with this.

### Manage your wireless networks

In this section we take the students to their history list of networks rather than the currently available networks. Most are not aware of this historical list and their ability to clear out any of the networks on the list. Most mobile devices have a similar list but the iPhone does not.

### ACCESS NETWORKED STORAGE

If the router has a USB port then it has the ability to provide a common storage area for everyone on the network. We put a music video on a flash drive in the router and students discover that they can connect and play the video on multiple machines. The most common error here is leaving the MAC address filter on from the previous section and finding one of the devices cannot get to the storage because it can't get on the network.

### Running out of time? Save your Configuration (OPTIONAL)

Most routers give the user the ability to save the router settings in a file on a computer. Our first attempts at this Lab ran long and so we used this as a way to be able to pick up where we left off if it could not be completed in one class meeting. Students always try to open the file once it is on their laptop so you need to explain that the file can only be used by a router and the laptop is just holding it to be placed on a router.

### Clean up after yourself

These routers now have all kinds of passwords, passphrases, encryption and other settings. It is very important that each router be reset back to the factory defaults. There are 2 ways to do this; through the menu system or with a physical button hidden on the router. Using the menu system is the easiest and if you can get the group to do that the router is all set for its

next group. If not the hidden button that requires a paperclip to push can be used but every company does the button a little differently requiring holding the button down while the router is plugged in for a very specific number of seconds.

### Questions

These are the questions we give the students to complete as part of the Lab.

1. Why is it critical that the router be on and connected to the computer used to set it up before you turn the computer on? (hint – from where does the computer get its IP address?)
2. What does the administrative password protect?
3. What SSID did your group use? What does an SSID tell you?
4. Where do the names of available wireless networks come from? How do you know from examining the list of names of available wireless networks whether or not a network is open or uses encryption?
5. When might it be preferable to connect to the Internet using a Wi-Fi connection rather than a cellular connection on your mobile device?
6. Enter the information from the IPv4 and MAC address table below in your lab report.

Device	IPv4 Address	MAC Address
Computer #1		
Computer #2		
Mobile		

Why should you look for Computer 1's IP address under the Ethernet Adapter Local Area Connection, and Computer 2's IP address under the Wireless LAN Network Connection section of the ipconfig results?

7. In "Attached Devices" which devices are associated with the IP addresses listed?
8. Is anyone else connected to your network? (How do you know?)

9. Once you disconnect computer #2 and your mobile device from your wireless network, open a web browser and visit a web site such as google.com. Do you have Internet connectivity? If so, to which network are you connected? If not, why did you lose connectivity?
10. How do networks that don't broadcast their SSIDs appear in the "Connect to a Network" dialog box?
11. Consider a network that doesn't have encryption and also doesn't broadcast its SSID. Do those two things make your network more secure or less secure? (explain)
12. What does adding WPA2 encryption do for your network?
13. Name three different steps you took to secure your network so far.
14. Can you add encryption without using a passphrase?
15. Why would you want to add this level of security (MAC address filtering) to your network? (please explain)
16. How can you configure computer #2 to remove or forget the name of the network you created in this exercise? (Write the steps to accomplish this on computer #2.) Take a screenshot showing the names that appear on the list of Wi-Fi networks stored on computer #2. Where did they come from?
17. How can you configure your mobile device to remove or forget the name of the network you created in this exercise? (Write the steps to accomplish this on your mobile device.) Take a screenshot showing the names that appear on the list of Wi-Fi networks stored on your mobile device. Where did they come from?
18. What could you use this "Network Storage" for on your network at home? (Each group member should answer the last two questions individually with their name on their answer in the report.)
19. What part of this lab exercise gave your group the most trouble and why?

20. What did you learn from this exercise? (Each group member should answer this question individually with their name on their answer in the report.)

### 3. LEARNING OUTCOMES

This exercise has been run with 30 sections of Bentley's Introduction to IT course for 4 years. Although we have not specifically tested for results from the exercise the number of times the Wireless Router Lab is mentioned positively in teacher evaluations is significant. We are also hearing from graduates that this exercise was helpful to them in their initial work environment. It would be to our benefit to do some research into how it is impacting their views of Information Technology.

### 4. CONCLUSIONS

This paper provides a technique to motivate freshmen to learn computer technology by requiring them to build a protected wireless network. The intent is to awaken an interest in the computer discipline by providing the tools and knowledge to help them understand something they use daily but do not understand or assume is too difficult. Once the network is built the students layer various security options on the wireless network. It is always important to expose students to new ideas and knowledge that allows them to make better use of the technology around them. This networking exercise will enable and motivate students to take another look at information systems as a course of study. It will also give them self confidence in dealing with their home networks when they go home.

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## Appendices

### IT101 Wireless Router Lab

In this lab exercise you will learn to create a wireless network, and connect computers to it with and without encryption and interact with networking tools in the Windows 7 operating system. These instructions assume that you are using computers that have been maintained to the Bentley standards. That means weekly scans for both virus and spyware activity, no file sharing and safe Web surfing. This Lab requires the group to follow the instructions step by step. Do not skip or ignore any steps or you will have problems later in the Lab. Read the steps carefully as you do them. The questions found throughout this Lab report are very likely to appear on the Final Exam for IT101 so make sure you know the answers by the time you have finished the Lab.

#### WHAT YOU NEED TO KNOW BEFORE STARTING

- How to connect your computer to a wireless network
- How to use a web browser
- How to determine a computer or mobile device's MAC address and IP Address
- How to recognize a router, and what a router does
- How to use Google Docs to create, edit, and share a document
- How to take a screen shot on your computer and mobile device

#### HARDWARE

- 1 Netgear Dual Band Gigabit Wireless Router
- 1 computer equipped with wireless networking capabilities
- 1 mobile device equipped with wireless networking capabilities
- 1 computer equipped with an Ethernet adaptor (any wireless should be turned off)
- 2 Ethernet cables – one blue and one yellow
- 1 USB flash drive

#### SOFTWARE

- Windows 7 on your laptop (other operating systems work but the directions are different from what is presented here.) If you have a computer that is not running Windows 7 in your group, please use it for computer #1 since that machine is only using a browser.
- A Web browser (Internet Explorer, Firefox, Safari, Chrome, etc. all work equally well)
- Gmail accounts for **all** group members

#### Lab Report

Your group will collaborate to complete a lab report as a Google Doc containing several screen shots and answers to questions that appear within these instructions. Decide among yourselves which questions each person will work on for the lab report. In many cases you will be creating screen shots or taking digital photographs. Take notes as you go along on this lab report, and upload your notes and images to the Google Doc either as you go along, or shortly after you complete the exercise.

You should NOT write your part of the lab report in Microsoft Word and paste it into Google Docs all at once. Each member of the group should contribute to the Lab report. Your instructor can identify what

was added to the Google Document by each member of the group so try to distribute the work evenly. Note that you cannot take too many screen shots. When in doubt, take a screenshot. That screenshot might save your group's Lab report!

**Note: To take a screen shot and insert into a Google Document, you will need to save the screen shot in an image file format (such as JPG or PNG) on your computer, and then use Insert Picture to locate the file and add it to your Google document.**

*Questions for your group to answer in your lab report appear within the lab procedures. Please note the answers to each question or take the required screen shots and/or pictures before moving on to the next step.*

### **GROUP MEMBERS AND ROLES**

There should be three people in your group, each managing a different PC. Decide which of you will take on each of these roles:

- Role #1: This person is responsible for configuring the router using a personal computer (referred to as Computer #1 in the steps below).
- Role #2: This person will connect a personal computer (referred to as Computer #2 in the steps below) wirelessly to the network. There should not be ANY Ethernet cables connected to this computer.
- Role #3 : This person will connect a mobile device wirelessly to the network.

The instructions identify each role by the corresponding number (1, 2, or 3). Be sure you know which role you are taking on before you continue. A 4<sup>th</sup> person can follow the same steps as Role #3 on a personal computer if you need to have 4 people in a group.

Your group will work together to build a wireless network and answers the questions that appear within these instructions. Your Lab Report is worth 5% of your course grade for IT101 so make sure you pay attention to all the details.

### **create your wireless network!**

#### **Create the Google document for your lab report**

One person in each group should create a Google Doc for your group's lab report, and invite the other group members and the instructor as collaborators. You will need the Google ID's for each person in your group, and your instructor. All group members should open Google Drive and access the lab report document so that each person can edit it at the same time as you complete the exercise. Please create the Google document right now if you have not already done so.

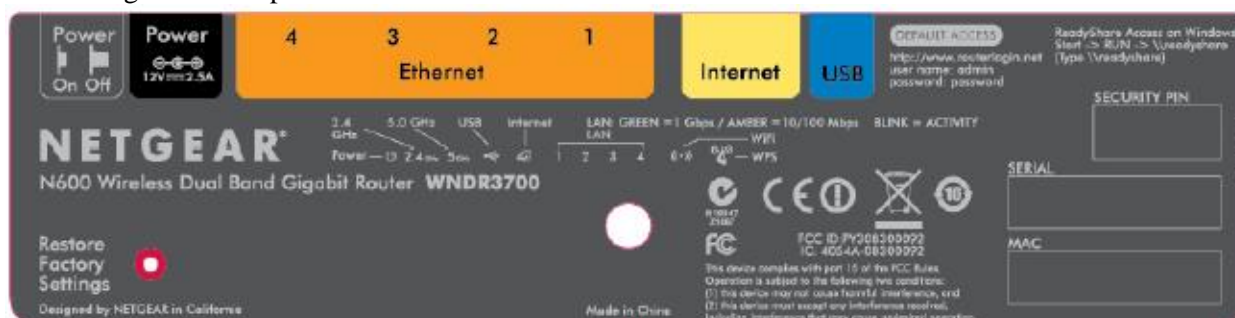
- Download the Lab Report Template from Blackboard. Create a new Google Doc, and then import the template into Google Docs.
- **Enter the names of everyone in your group at the top of the document.**
- **Rename the document to S14IT101XXX Router Lab – LastName1, LastName2, LastName3 where XXX is your section number, and each group member's last name is given.**

#### **CONNECT THE ROUTER to the wired computer**

Your first task is to get the router up and running. It takes several minutes for the router to boot and then the wired computer connected to it has to boot which takes forever. Please get the router booted up and running as quickly as you can and then take your time to do the rest.

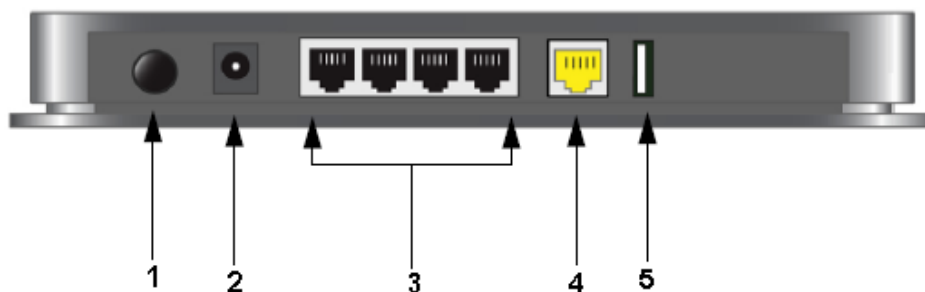
1. Completely power down Computer #1 (the “wired” machine, to which you will connect the router with an Ethernet cable).
2. Identify the ports on the back of the router. Starting at the bottom just above the power button there should be a place to plug in the power cord, 4 LAN ports (black interiors), one WAN port (yellow interior) and one USB port.
3. Connect the wired computer (Computer #1) to the router making sure the cable connects to one of the 4 LAN ports (black ports). (a blue cable would be good for this)
4. Connect the WAN port (yellow port) on the router to a working Internet connection using an Ethernet cable. (a yellow cable would be good for this)

There is a guide to the ports on the bottom of the router:



## Back Panel

The rear panel of the WNDR3700 router contains the items in the list that follows the figure.



**Figure 3**

The back of the N600 wireless gigabit router includes:

1. A Power On/Off button.
2. An AC power adapter outlet.
3. Four local (LAN) 10/100/1000 Mbps Ethernet ports for connecting the router to local computers.
4. An Internet (WAN) 10/100/1000 Mbps Ethernet port for connecting the router to a cable or DSL modem.
5. A USB 2.0 port (backward compatible to USB 1.0/1.1) for attaching a USB storage device.

5. Power up the router by plugging the power brick into an outlet and the router. If nothing happens press the power button at the bottom of the back panel.
6. There are LED lights on the front of the router to give you the status of the router. Watch the icons on the router as it boots. The top led is just to show that the power is on. It is yellow when the router is first turned on and changes to green after the router is booted and operational.
7. The next 2 lights are for the two wireless radios in this router, green for the 2.4 GHz radio and blue for the 5 GHz radio (Most older routers only have 1 radio for wireless. Many newer routers have 2 like this router). Both of these lights will light but take a full minute after the router is powered up to appear.
8. The 4<sup>th</sup> light is for a USB storage device that can be connected to the router. It will be lit if a memory stick is plugged into the back of the router.
9. The next light is the Internet light. As long as you have a good Ethernet wire connection to a working Internet port this light will light green. If this light is not lit you need to check your Ethernet cord and maybe try another network port on the table. **\*\*without this connection no one in your group will have Internet access while connected to your network\*\***

**IF YOU DO NOT HAVE 4 or 5 (not 3) LIGHTS LIT AT THIS POINT, NOTHING IS GOING TO WORK. PLEASE GET SOME HELP IF YOU DO NOT HAVE 4 LIGHTS LIT ON YOUR ROUTER NOW!**

10. When you have the 4 or 5 lights lit on the router power **up the wire connected computer** and log into Windows. The 6<sup>th</sup> position light on the router should be on for a total of 5 or 6 lit lights. The current HP computers light this light even if they are not booted because the Ethernet port has power even when the computer is off.

*1. Why is it critical that the router be on and connected to the computer used to set it up before you turn the computer on? (hint – from where does the computer get it's IP address?)*

#### Configure the router on the wired computer

11. Open a web browser on the wired computer.
12. In the browser's address bar, type the IP address **192.168.1.1** and press <ENTER>.
13. You will be prompted for a username and password. For the Netgear WNDR3700 the username is: **admin** and the password is: **password** . These are the default username and password for this router. The default settings for any router can be found on the Internet.
14. You will get a Netgear screen of one kind or another. Regardless of what screen it is, **we are not making changes here yet**. There is a very important task to do first, change the router's password. On the left side of the screen is a menu list. It is subdivided into groups because some of the menu items are the same but apply to different parts of the router. Scroll down (there are three different sections to this Web page and each has its own scroll bar. Be careful where you scroll) to the 4<sup>th</sup> group labeled "Maintenance". **In that group click on "Set Password"**.
15. Change the administrative password to something that you write down on this sheet. Use all of your password knowledge to build a good password. Do not use your Bentley password; others in

the group may use the password during the exercise. Keep in mind that this password has nothing to do with the wireless connection. It is the password that allows anyone to make changes to EVERYTHING on your router. Only the person authorized to make changes to how the router works should have access to this password. It has nothing to do with who can access the network!

## 2. What does the administrative password protect?

16. The router immediately will prompt you to log in again. You will need to use the new password this time and it will take you right back to the “Set Password” screen.

17. Login using your new password and **ignore any questions on the screen.**

PLEASE NOTE: changes you make to the router do not take place instantly. **The router requires some time to process and actually make the changes.** Although the screen may come back quickly it will still be a minute before the changes you made will take effect. Take a breath and give the router a chance to do what you are asking!

**Set the SSID For your Network on the wired computer**

18. On the far left menu, click on “**Wireless Settings**” in the Setup group to get the first wireless settings page.

The screenshot shows the Netgear Smart Wizard router manager interface. The main content area is titled "Wireless Settings" and is divided into three sections: "Region Selection", "Wireless Network (2.4GHz b/g/n)", and "Wireless Network (5GHz a/n)". The "2.4GHz" section is currently active, showing options for enabling SSID broadcast, setting the SSID to "NETGEAR", and selecting security options like WPA-PSK [TKIP] or WPA-PSK [AES]. The "5GHz" section shows options for enabling SSID broadcast and video network. A "Wireless Help" sidebar on the right provides additional information and tips for optimizing wireless connectivity.

If any of the router screens are left untouched for more than 2 minutes the login screen will pop-up when you finally do try to make a change. This is perfectly normal and should not cause any problem as long as you know the router’s administrative password.

19. There are 2 wireless radios on this router, so there are two places for each of the setup items. **On the first radio** the default SSID is NETGEAR.

Create an SSID for your group by using the first three letters of the first name of each person in your group. (For example, **bilmardou** for Bill, Mark, Doug). Use this nine-character string as the SSID. Type it in entirely in lower case. *NOTE: The SSID is case sensitive just like a password.*

**For the second radio** NETGEAR-5G is the default SSID. **DO NOT CHANGE ANYTHING OR CONNECT TO THE NETGEAR-5G RADIO!** We are going to totally ignore the NETGEAR 5-G portion of the router in order to keep things simple. Please make sure all of your changes are to the first radio which now should now have a 9-character name, as the SSID.

Please make sure to click the **Apply** button at the bottom to save your changes on this screen. The router has to reboot so it will take a few minutes before the 2 radio LED lights come back on. **DO NOT DO STEP 20 UNTIL THE LIGHTS COME BACK ON!**

*3. What SSID did your group use? What does an SSID tell you?*

Connect a computer or mobile device **TO** your wireless network

20. Follow these steps to connect computer #2 to the wireless network.
- Open the dialog box that shows what wireless networks are available from the Wireless icon in the Windows Notification Bar located near the clock in the lower right-corner of your desktop.
  - Click on “Refresh network list” to ensure you are not looking at old information. You should see your group’s SSID name on the list. Do not connect to anything with a –5G, as that represents the second radio.
  - Click your network’s SSID name** and then click **connect** at the bottom of the list. You may get a warning window about the danger of connecting to an unsecure network. Click on **Connect Anyway**.

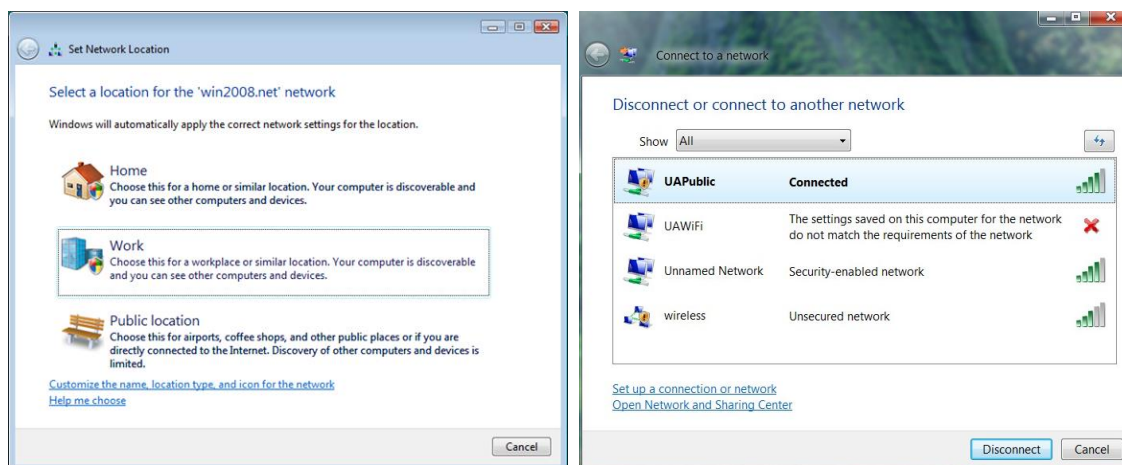


*4. Where do the names of available wireless networks come from? How do you know from examining the list of names of available wireless networks whether or not a network is open or uses encryption?*

*5. When might it be preferable to connect to the Internet using a Wi-Fi connection rather than a cellular connection on your mobile device?*

**Note: In Windows 7, the first time you connect to a network, sometimes you are asked to classify its location type as home, work, or public. When you are connected to a public location, Windows 7, if told it is a public location, disables all network and sharing to protect your information. You can change what kind of connection it is at any time by modifying the settings for that connection.**

**Windows may not display the Set Network Location dialog box immediately. You may continue with the exercise regardless of whether or not you set the network’s location.**



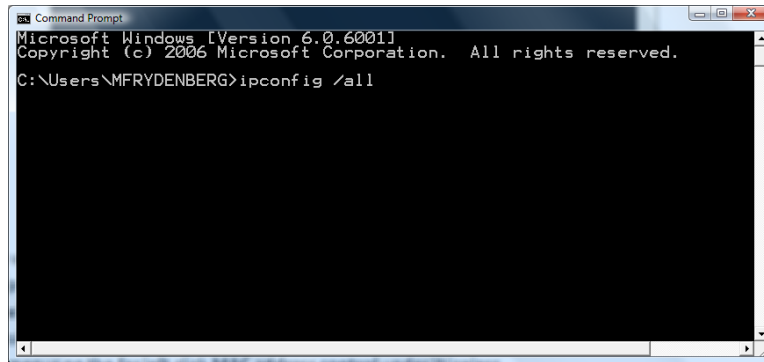
21. Follow these steps to connect your mobile device to the wireless network.
  - a. Look for wireless options on your device's settings screen to configure wireless access.
  - b. Select the SSID of your wireless network to connect to it.
  - c. If necessary, use a search engine to find more complete instructions on how to connect your particular mobile device to a wireless network.
22. **Computer #2 and your mobile device should now be connected to your wireless network.** If the router has Internet access, the wireless computer and mobile devices also should have Internet access. Open a browser on the computer and mobile device connected wirelessly to your network and see if they can connect to a site on the Internet.

#### Find the IP and MAC addresses of your computer AND mobile device

Your computer or mobile device's IP address consists of 4 numbers separated by periods. It may also be called the IPv4 address. If your device has an IP address, which verifies that it is connected to a network. The MAC address (sometimes called the *physical address*) consists of 6 sets of two digits separated by dashes or colons. It is a number that uniquely identifies your device.

You will need the IP address of your computers or mobile device to verify your connectivity to the network using the Attached Devices list (see step 24). You will need the MAC address so you can allow specified devices to access your network. (See step 30).

23. Follow these steps to find the IP and MAC addresses for Computers #1 and 2, and your mobile device.
  - a. To find this information in Windows:
    - click the **Start** button in the lower left corner and select "All Programs".
    - Select "Accessories" and then "Command Prompt".
    - In the command window, type **ipconfig /all** and press <ENTER>. (make sure there is a space between ipconfig and the /).



Issuing the ipconfig /all command generates several screens of information. **Each Bentley computer has 3 MAC or physical addresses associated with it, so make sure you are looking at the correct one for your machine's connection.**

When looking at the results of the ipconfig /all command, Computer #1's IP address (IPv4) and physical (MAC) address are located under *Ethernet adapter Local Area Connection*. Computer #2's IP address is located under *Wireless LAN Adapter Wireless Network Connection*.

b. To find your IP and MAC address on your mobile device:

- On an iOS device, from the Settings app, tap Wifi, locate the network to which you're connected, and tap the arrow near the network name to reveal the IP address. Tap Settings, General, About to find your MAC address.
- On an Android device, tap Settings, Device Settings, Status to view your IP and MAC addresses
- Use a search engine to find more detailed instructions to find your IP or MAC address on your device if necessary.

**Write down these values for each device and include them in your Lab Report**

Device	IPv4 Address	MAC Address
Computer #1		
Computer #2		
Mobile		

6. Enter the information from the IPv4 and MAC address table above in your lab report.

Why should you look for Computer 1's IP address under the Ethernet Adapter Local Area Connection, and Computer 2's IP address under the Wireless LAN Network Connection section of the ipconfig results?

**SEE WHICH DEVICES ARE CONNECTED TO YOUR NETWORK**



24. The Attached Devices list (on the Netgear menu) identifies the computers connected to the router by their IP addresses (and specifies whether they are connected via a wired or wireless connection). On the wired computer, click the menu choice **Attached Devices** on the router's menu list to see a list of what computers are connected to it.

*7. In "Attached Devices" which devices are associated with the IP addresses listed?*

*8. Is anyone else connected to your network? (How do you know?)*

You can use the Attached Devices menu choice on the router at any time to check and see who is actually connected to your router. Remember this tool as you do the rest of the Lab.

**Important note:** You cannot see MAC addresses or IP addresses for other computers in the black box. Only your computer's information will show there. The router sees all of the computers and the Attached Devices menu option on the router will show you everyone attached to that router.

25. **On computer 2 and your mobile device, choose Disconnect from a network to disconnect them from your wireless network.**

*9. Once you disconnect computer #2 and your mobile device from your wireless network, open a web browser and visit a web site such as google.com. Do you have Internet connectivity? If so, to which network are you connected? If not, why did you lose connectivity?*

For the next three sections, keep in mind that your router has 2 radios. Make the changes listed to only one of the radios so you can see the difference between what happens on the one you are changing. Experiment with both machines and switch connections to see just how your changes affect both machines. The first radio is the one you want to change and these changes only affect the network that has your SSID. When the Lab tells you to connect to the wireless network, **it is referring to the one with your SSID not the NETGEAR-5G network.**

**STOP broadcasting your network's ssid**

26. On the router in the Wireless settings, uncheck **Enable SSID Broadcast** on the Wireless Settings screen. Click Apply at the bottom of the screen. This does not shut off the network, it only hides the name. On computer#2 and your mobile device (which now are disconnected from your network), determine the wireless networks that are available. Your network SSID should not appear. You will find networks at the bottom of your available wireless network list that have hidden SSIDs. One of these is probably yours but without an SSID there is no way to tell.

To connect to your network using Computer #2

- Left-click the wireless icon in the bottom right-corner of the task bar to see a list of available networks and indicate if you are connected to any of them. (If you are connected to airfalcon please click disconnect)
- At the bottom; click on "Open Network and Sharing Center".
- On the left side of the Network and Sharing Center screen click on "Manage Wireless Networks".
- You should see your network on the list.

- **If your network is on the list**, right click it and click properties. You will get a list of three check-off boxes for Auto Connect, Preferred Network and “Connect even if the network is not broadcasting its name”. You should check the first and last ones but not the middle one. Also note the Security tab which you will be coming back to when we do the security part of this exercise.
- **If not** click “add” at the top, click “Manually create a network profile” and add the information about your network. You are required to select a security choice and at this point you have none so select the “open” option. Note the check box for automatic start (if checked your computer will automatically connect if it sees this network) and the one for “Connect even if the network is not broadcasting” which needs to be checked if you want to see your network when the router is not broadcasting the SSID. Click next and then close.

**Note:** You may find that your computer has added a 2 next to the SSID on your computer. The SSID has not changed, the 2 is not part of the name. This is how Windows avoids confusion if an SSID has been added to the list when there is already one there with that SSID. You can always delete the old one.

To connect your mobile device to a network with a hidden SSID:

- On an iOS device, tap Settings / WiFi Networks / Other, and enter the network information.
- On an Android device, tap Settings, Wi-Fi, Add Wi-Fi network, and enter the network information.
- Use a search engine to find more detailed instructions to find your IP or MAC address on your device if necessary.

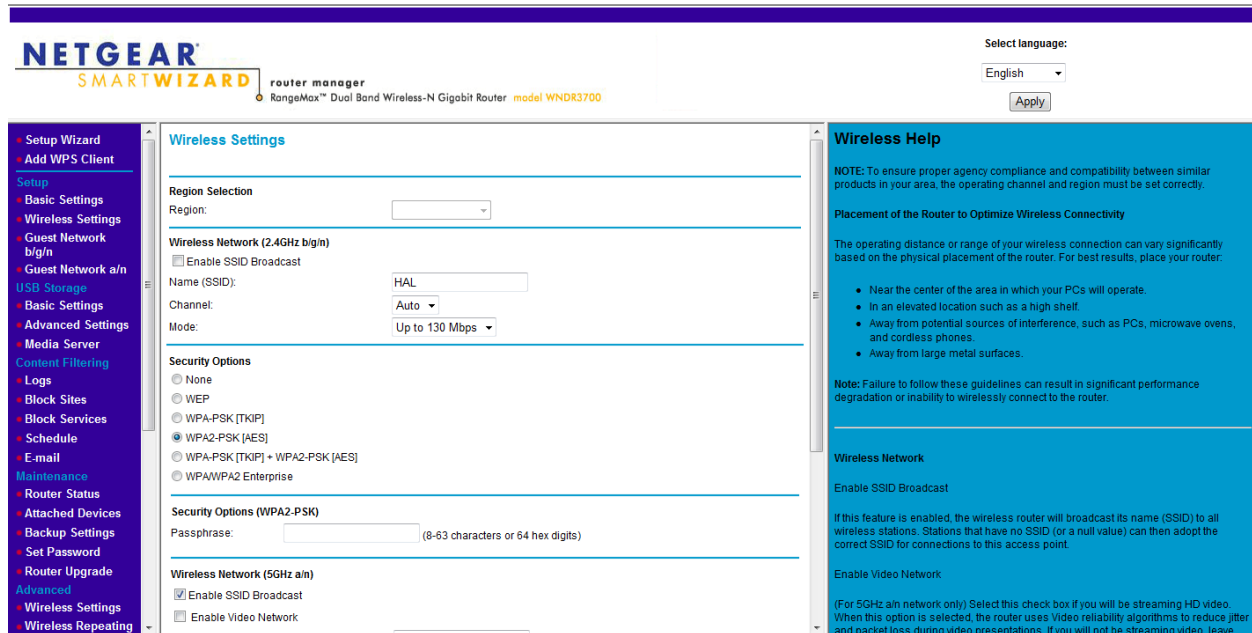
After you have completed **one** of the two options above you should get your network on the list of available networks and you should be able to connect. Verify that you are connected (how?). If you cannot connect your settings for that network do not match the settings for the network on the router. The settings must match for the computer or mobile device to connect.

10. How do networks that don't broadcast their SSIDs appear in the “Connect to a Network” dialog box?

11. Consider a network that doesn't have encryption and also doesn't broadcast its SSID. Do those two things make your network more secure or less secure? (explain)

### ADD encryption to your network

27. **On the router:** (Computer #1) click on the **Wireless Settings** choice on the far left side if you are not already there.
28. Change the security from “none” to “WPA2-PSK [AES]“. The screen should look like this:



Add a key (Passphrase) to this screen. This is a very tricky task as explained on the router security page. You can type in a phrase as long as it is between 8 and 64 characters and the software will convert it to a hex string or you can type in a 64 character hex string. Many people use a word or phrase that they can easily remember. If you prefer using a hex string, use this one: **11bb22bb33bb44bb55bb66bb77** . As with all passwords this string is case sensitive. Please write down the password you use so you will have it for future reference.

29. Click **apply** at the bottom of this screen and wait, **this change will take a few minutes to go through**. Refresh your list of wireless networks on the wireless. **You will need to reconnect both devices**. When you do, it will prompt you for the key (passphrase) and you must type it in correctly. **Remember, the key is case sensitive!** **If you have trouble connecting use the same process you used earlier to modify each wireless device’s settings for your network**. You will need to add the encryption settings on the Security tab of the Properties window for your SSID. Again, if the settings on your computer match the settings on the router you will connect. If the settings do not match there is no way you can connect.

Note: If neither computer can connect to the network, reconfigure the router using computer #1 to broadcast its SSID. See if that helps. Make sure that on computers 2 & 3, Security Type is set to **WPA2-Personal** and that Encryption Type is set to **AES**. The passphrase is case sensitive so make sure that is correct too!

12. What does adding WPA2 encryption do for your network?

13. Name three different steps you took to secure your network so far.

14. Can you add encryption without using a passphrase?

#### **ALLOW network ACCESS Based on MAC ADDRESS**

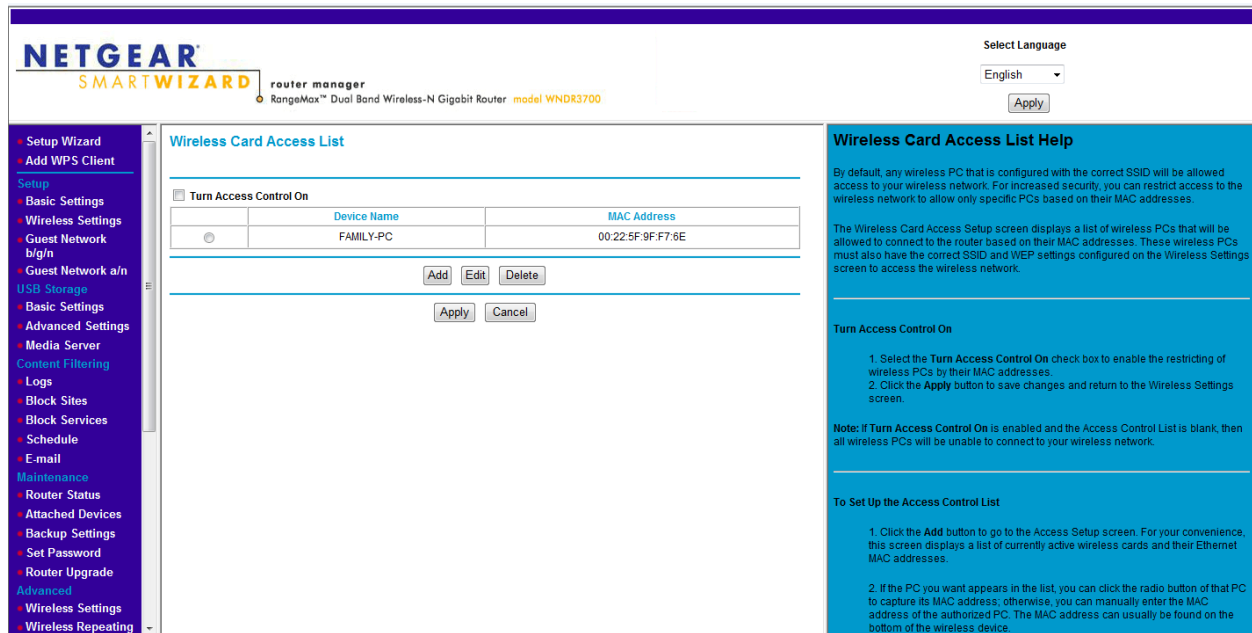
To make the network even more secure, specify the MAC (physical) addresses of only those computers that can connect to it. In this section you will let computer #3 access the network by entering its MAC address. Computer #2 will not be able to access the network.

30. Find the MAC address of your mobile device so you can let it access your network. (See step 23). **Make sure you have the wireless MAC address and not the Bluetooth or Local Area Network MAC addresses!**

31. Using Computer #1, follow these steps to configure the router to permit access based on MAC address:

- Click on the other **Wireless Settings** in the **Advanced** group.
- Near the bottom of this screen find "Wireless Card Access List"
- click on "Set Up Access List".
- Check the box "Turn Access Control On" and click add.
- If the wireless device appears in the **Available Wireless Cards** list, you can select the radio button of that device to capture its MAC address.
- If your wireless device is not listed, make sure that it is configured correctly, and then click the **Refresh** button to update the list of available wireless devices.
- If computer 2 is on the list but not the mobile device, then add computer 2. If the wireless device is still not listed you can add the MAC address and whatever description you would like. Use the instructions to the right on the Netgear screen for more detail. **You must check the box at the top to "Turn Access Control On". Often this requires 2 tries to get the check in the box to stay.**

NOTE: This is a very poorly designed page on the router. There are actually 2 lists, one of the connected machines and one of the MAC address on the list to get access. It is very difficult to tell just which list you are looking at. It's not you that is the problem. Whoever designed this for Netgear hopefully is not working there anymore.



32. Verify that your mobile device can connect to your network, but computer #2 cannot (assuming both could connect before you enabled MAC address control).

15. Why would you want to add this level of security (MAC address filtering) to your network? (please explain)

### Manage YOUR Wireless Networks

33. On computers 2 and 3, open the Network and Sharing Center (from the Control Panel or from Network Settings in the notification bar) and select Manage Wireless Networks. This page contains the names of every network you've ever connected to and saved settings on your computer. You may want to clean up this list if there are networks listed to which you don't connect frequently. If you right click on your network and choose Properties you can modify the connection settings for your network.

On your mobile device, view the Wi-Fi settings page to see names of networks to which you previously connected. Use a search engine to find instructions specific to your mobile device that describes how to remove names of no-longer-needed wireless networks from the list.

16. How can you configure computer #2 to remove or forget the name of the network you created in this exercise? (Write the steps to accomplish this on computer #2.) Take a screenshot showing the names that appear on the list of Wi-Fi networks stored on computer #2. Where did they come from?

17. How can you configure your mobile device to remove or forget the name of the network you created in this exercise? (Write the steps to accomplish this on your mobile device.) Take a screenshot showing the names that appear on the list of Wi-Fi networks stored on your mobile device. Where did they come from?

#### ACCESS NETWORKED STORAGE

34. Verify that computer 2 is connected to your network by adding its MAC addresses or turning off the Access Control.
35. To access network storage (this is really cool!) – connect a USB flash drive to the USB port on the back of the router. On each the two computers click on Start and then right-click on “computer” (on the right side of the menu). Click on “Map network drive...”. In the “Drive:” box choose the letter J:. In the “Folder:” box type: \\readys\share\USB\_Storage and click Finish. A new file explorer window will open showing the files and folders on the flash drive. Everyone on your network can map and access the files on the USB flash drive. If you had a movie on the USB flash drive everyone on your network could watch it on their own machine. (make sure the USB Flash Drive is correctly plugged in to the router) Turn on your sound and play the video on the flash drive.

18. What could you use this “Network Storage” for on your network at home?

#### Running out of time? Save your Configuration (OPTIONAL)

36. **OPTIONAL** – This step should only be done if you do not have enough time to finish. You can save your router setting in a file on your wired computer. This would allow you to return the router to where you are now without going through the whole exercise again. To do this click on the “Backup Settings” on the router’s left side menu and then click “Back Up”. Make sure you know where you are saving the settings on your computer. When you connect the new router (any Netgear WNDR3700 router) click on the “Restore Saved Settings from a File” option under Utilities in the router’s left side menu and follow the instructions to restore your settings. Everything you set **including the router password** will be restored to where they were when you saved them.

#### Clean up after yourself

37. When you have completed everything you want to or are required to do, **you need to restore the router to its original state**. This step will remove all of the changes you made to the router so don’t do it unless you have completely finished the lab exercise. If you finish early – go back and start answering the questions. Make sure you have everything you need for the report **BEFORE YOU RESET THE ROUTER!**

Choose **Backup Settings** from the far left menu. Click on **Erase** then click YES. An “Updating Settings” window will display. It will require approximately 2 ½ minutes to clear the router and a

login screen will pop up when it is finished. **DO NOT DO ANYTHING ON THE WIRED COMPUTER WHILE THIS IS TAKING PLACE. THIS IS VERY IMPORTANT – THE NEXT GROUP WILL NOT BE ABLE TO USE THE ROUTER UNLESS YOU RESTORE THE DEFAULT SETTINGS CORRECTLY!**

*(Each group member should answer the last two questions individually with their name on their answer in the report.)*

*19. What part of this lab exercise gave your group the most trouble and why?*

*20. What did you learn from this exercise?*

Please make sure that your computer or mobile device can connect to airfalcon after you complete this lab exercise. If you have any trouble connecting do a full Windows shut down and then start the computer again. You should automatically connect to airfalcon but if not look at your available wireless networks list. You should be able to find airfalcon and the knowledge you obtained in this lab will allow you to open the properties of airfalcon and make any adjustments necessary.

### **Complete your lab report**

Review your lab report. Make sure you answered all of the questions and included all of the screenshots and photos. Check with your instructor as to when your lab report is due. Submit the final lab report by sharing it with your instructor's GMAIL account ([?????????????@gmail.com](mailto:?????????????@gmail.com)) on Google Drive as a collaborator.

**Please make sure that all of the members of your group are listed by name at the beginning of the Lab Report since your instructor may not recognize you by your Google name!**

## IT101 Wireless Router Lab Instructor's Guide

The IT101 Wireless Router Lab has proven to be very popular with students. It can be very frustrating for instructors unless some prep work is done ahead of time. This guide is designed to help you through the Lab and provide some of the answers to the questions the students will ask. Keep in mind that wireless networking can be very frustrating and that is one of the lessons of the Lab.

It is almost impossible to do this Lab effectively if you have not gone through the student instructions step by step yourself. Two of the routers are almost always available in the Smith 234 Lab and it is recommended that you go to the Lab and spend an hour doing the exercise before you present it to your students. You can connect the router to one of the Lab machines and use your laptop for both computer #2 and computer #3. Even better, find another IT101 instructor and do the Lab together!

One of the most annoying issues we see every time we do this Lab is computers that are infected with spyware or viruses. This Lab stresses the machine and if it's not clean the students will

experience strange and unpredictable results. Before you do the Lab re-emphasize the need to run scans for both viruses and spyware. I suggest having them run malwarebytes available from <http://www.malwarebytes.org/> This is a scan that takes a long time so don't run it in class.

### **WHAT YOU NEED TO KNOW BEFORE STARTING**

This section of the Lab explains what the students need to know before they start. All but the last item are normally known or covered in class in the normal flow of IT101. Using Google Docs is not familiar to most students. You can skip the Google Docs/report part of the Lab but if you do they will not do everything in the Lab and some will just tune out. The Google Docs part of the exercise is designed to show them a collaborative tool that is actually used in business. The best thing you can do to make this work is to have them all setup Google accounts at least a week before they do the Lab. Some will already have accounts but probably have never used the documents or the calendar portions. For those who do not have Google accounts, suggest that they use the Gmail account as a "throw-away" email account when they fill in forms on-line. Have them build a document, past a screen shot into it and share it with you. You cannot paste anything except text directly into a Google Document so the screen shots need to be saved and the file is inserted into Google Docs. The instructions for this are now part of the Lab instructions. The other issue that has come up in the past is that students write the Lab up in Word and then just past the whole thing into Google Docs. This negates the whole concept of collaboration. Get them to all open the document during the Lab so that they can each add to it as they go along. When you are in the Google Document that they give you access to, you can pull down on the edit menu and click on "Revision History". This will list exactly who did what in the document. You can identify anyone who did not do much on the report through this tool. Telling them ahead of time will generally avoid the issue altogether.

### **HARDWARE**

The only issue here is:

They need to be in groups of three. Four works, two doesn't. The wired computer (#1) should be in the center of the group to encourage full participation by the entire group.

### **SOFTWARE**

If you have anyone not using Windows 7, things will work but getting to the wireless setup is different. They should be able to handle it if they have done the rest of the course in something other than Windows 7. It would probably be good to use a non-Windows 7 machine as the wired (#1) computer if there is one in the group. Even an Apple could be used for the wired machine if necessary.

It really helps if you download and try out inSSIDer before they do the Lab. The package allows you to give them "the big picture" of what is happening in the room. I put inSSIDer up on the screen from my laptop so that everyone (including me) can see who's up and broadcasting.

### **GROUP MEMBERS AND ROLES**

Emphasize that all changes to routers should be made on wired connections only. Making changes through wireless is very dangerous and should be avoided. The person sitting at



computer #1 can switch with other people in the group so everyone gets to make changes on the router.

### Lab Report

One issue here is how to do screen shots of the available networks. There are many ways to do it and this is a good example to use to show that sometimes one way doesn't work and other (sometimes older) way must be used. The Windows snipping tool is probably the way most will try to do it but this is a new Windows tool that most students are not aware of and in this case it doesn't work. Some of them are aware of the OneNote tool (Windows key + S) but this doesn't save in the correct format for pasting into Google Docs. Good old PrtScr is the other way and it is a good thing for them to be familiar with. The best format for saving is .gif and those will easily insert into Google Docs.

#### CONNECT THE ROUTER TO THE WIRED COMPUTER

At least 2 of your groups will connect the wires wrong. If they pay attention to the instructions, they will realize the problem before they boot the wired machine. Most groups don't. This means that they lose time figuring out what is wrong and then lose even more time shutting down and starting up the wired computer again. There is a short cut to this that will avoid the reboot but you need to practice it before you try it in class. You don't even need to be connected to a router to try this out but you do need to be connected to some network (wired or wireless). Click on the Start button and go to All Programs->Accessories and right click Command Prompt. Click on Run as Administrator. You will get the black "DOS" window that looks just the same as if you had clicked on run but because you are an administrator you can use the following commands that will not work otherwise. At the prompt `ipconfig /all` will list all of the ip addresses and MAC (physical) addresses just like the students will be doing in step 23. You don't need this now however. Instead, type `ipconfig /release` . This will release every IP address for all network connections. When the prompt comes back type `ipconfig /renew` . It will take a minute but the machine will attempt to renew the IP address on every network connection it has. In the case of the wired computer, it will get a new IP from the router without doing a reboot (assuming that the wires are now set up correctly). This can save 15 minutes for the group that got started wrong.

If the last group that used the router did not reset it to default the group using it now will not be able to get into the router because it has a password that only the last group knows. The simplest way to deal with this is to get the group another router. They should not have to reboot the wired machine as its IP address should be valid on the replacement router. If no other router is available, you will need to do a physical reset of the router. This is done by depressing the reset button on the bottom of the router for 7 seconds while the router is on. The button is recessed and will require a paperclip or something to depress. Keep holding it down until you see the lights go out. It may require more than one try to get it reset.

#### CONFIGURE THE ROUTER ON THE WIRED COMPUTER

The thing to emphasize here is that the router has a Web page built in so the wired machine is going to that page, not a site on the Internet. Every setting on the router that can be changed is changed through the browser using the built-in Web page. The toughest part is figuring out just where on the page a particular setting is. The Lab instructions point them to the correct menu choice if they read it.

Changing the password on the router is a primary security measure. Otherwise anyone can get into the settings page and change the settings. In the classroom with all of those routers fired up, one group could accidentally change another group's settings leaving both groups totally confused. This is also a good time to mention that changes on the router do not take place instantly. Many of the changes require the router to reboot which takes time. Even the changes that do not require a reboot take a couple of minutes to take effect. Tell them to sit back and look ahead while they give the router a chance to meet their demands.

### SET THE SSID FOR YOUR NETWORK ON THE WIRED COMPUTER

This change will identify which router is which since the default is to show up in inSSIDer as a Netgear router. Remember to refresh the inSSIDer display to see the SSIDs show up on your monitor if you are using inSSIDer to monitor the airwaves of your class.

Keep in mind here that each of these routers has 2 radios. To save confusion the students have been told to label the two networks their router is broadcasting differently so they can make changes to and monitor just one of the networks. The most common mistake is to label them identically which leads to total confusion. Emphasize the need to label properly and then ignore the 5G network as they proceed.

### CONNECT TO THE ROUTER OVER YOUR WIRELESS NETWORK

Now we get the other 2 group members involved with their machines. Most will be connected to a campus network and may need to disconnect in order to connect to their own network. This is also where the problem computers (infected computers) start to give their owners trouble. Make sure everyone connects before they move on. It may be a good idea to take a minute to talk about the Set Network Location dialog box. This is really important for anyone connecting to an unknown wireless connection in a public place and is a great feature of Windows 7. Depending upon the state of their wireless connection, the Set Network Location dialog box may not show up.

Finding the IP address and the MAC (physical) address is a very important part of this Lab and one that is easy to test later. They need to understand that there is a MAC address for every network adaptor (three in the current HP machine, Bluetooth, wired and wireless) and an IP address for every current connection. The router tracks the machines that are connected to it by their IP address which is given to the computer by the router. The Attached Devices list shows everything connected to the router and becomes an important tool that the group can use at any time to figure out what is connected to their router and what is not connected.

### STOP broadcasting your network's ssid

This is the simplest security that anyone can apply. It doesn't give much protection from folks who use tools like inSSIDer but it keeps the average person out because they don't even know

the network is there. The most important part of this section is making the students familiar with the procedure for adding a network that doesn't show on the Windows list of wireless networks.

## ADD ENCRYPTION TO YOUR NETWORK

There are multiple types of encryption available on today's routers. The basic WEP that has been a standard since the beginning of wireless routers can be broken in less than 10 minutes with tools readily available on the Internet. WPA was developed as a replacement but was also broken. WPA2 was next and has also been broken. Older wireless cards cannot do WPA or WPA2 so these choices may not be good ones for homes with older machines. Some of the versions of WPA require a Radius server which most people do not have. The Lab uses basic WPA2-PSK which works without a server and is more secure than WEP. Students should be cautioned that it is almost impossible to make a wireless network secure and that the TJ Max break-in was done from a car in the parking lot using standard wireless networking.

Regardless of which encryption is used, the type of encryption used on the router must match what is used on the wireless computers or they will not be able to connect even with the correct password. Encryption does not affect any of the wired ports which is another reason to only make changes to the router through a wired machine.

The password (referred to as a key in wireless lingo) is required to be a hex string by the encryption software. Most routers like our Netgear allow the user to type in a word or phrase and the router converts it to hex. This is a good opportunity to introduce them to a good key for wireless which is an easy to remember hex string 11bb22bb33bb44bb55bb66bb77 .

Remind students that one tool they have when dealing with connection problems is to turn the SSID broadcast back on. If they can't connect with the encryption turned on, they should enable the SSID broadcast and see if they can get connected. If so, they should turn off the SSID broadcast while connected and see if they can maintain the connection or reconnect.

## ALLOW NETWORK ACCESS BASED ON MAC ADDRESS

Another security tool provided on most routers is MAC filtering. The user gives the router a list of valid MAC addresses and the router will only connect to machines with those addresses. This is a good exercise in that it gives them a reason to be able to find their various MAC addresses. Most will miss-type at least one of the group's MAC addresses and will have trouble connecting. Make sure the addresses they type in match the actual MAC addresses of the wireless machines again remembering that only one of the three MAC addresses each machine has will allow it access (the wireless MAC address). Like the encryption, the MAC filtering doesn't apply to wired machines so Computer #1 will still connect no matter how badly they mess up the MAC addresses. Again, make sure students are aware that MAC addresses can easily be spoofed and a simple tool that picks up wireless traffic can identify the valid MAC address and allow a rouge machine to spoof the address and still get into the network.

The screen where the MAC based access is set up is somewhat confusing. Netgear did not do a good job with this screen and most students are likely to have trouble differentiating between the list of MAC addresses available and the list of MAC addresses allowed a connection.

## MANAGE YOUR WIRELESS NETWORKS IN WINDOWS 7

We added this section to make students aware of the great tool Windows 7 has for managing the multitude of wireless networks that students encounter. Most students are not aware that Windows keeps a record of the wireless networks the machine has connected to in the past. They may want to do some cleanup here to cover their tracks.

## NETWORK STORAGE

The Netgear router has the ability to use a USB memory stick as a network storage device. Memory sticks are supplied with the routers so everyone can try this out. Make sure that the MAC filtering has been turned off or all machines have been added to the list. The computers must be connected to the group's network in order for the storage to work. There is a video on the memory sticks that is easy to identify when a group gets the memory working.

## CLEAN UP AFTER YOURSELF

This is a very, very important step. If the router is not returned to the default settings, the next group will not be able to get into the router. Please make sure every router gets reset before they disconnect the wired machine. Depending upon time, you may have some groups that are not able to finish the Lab. They can back-up the router settings to the wired computer BEFORE resetting the router. The backup will allow them to use any NetgearN600 router and restore their settings (including the router password) to the router. I keep 1 of the routers in a paper box in the Smith 234 Lab so that the students can go in and pick up where they left off with the router.

The router can be reset to default using the reset button on the router. This is much harder than the software reset. You must hold in the reset button for 7 seconds while the router is on in order to get a reset.

### **Complete your lab report**

Please make sure you replace the generic Gmail address with yours before you distribute the Lab to your students. The reason you need to be a collaborator rather than a viewer is that you do not get the "Revision History" tool as a viewer.