■ **ECE/CS 4984: Wireless Networking and Mobile Systems** ■

Pre-lab and In-class Laboratory Exercise 6 (L6)

Part I – Objectives and Lab Materials

Objective:

The objectives of this lab are to:

- Illustrate the set up of a Bluetooth Piconet.
- Identify the potential interference between Bluetooth and 802.11b.

After completing the assignment, you should be able to:

- Set-up a Bluetooth connection between two or more nodes;
- Mitigate the interference of Bluetooth on 802.11b.

Hardware to be used in this lab assignment:

- Xircom credit card Bluetooth adapter
- Xircom 802.11b adapter
- Dell Notebook

Software to be used in this lab assignment:

- Bluetooth connection manager
- Intellisync software
- *netperf* running on the notebooks

Part II – Pre-lab Assignment

- Read the *netperf* manual installed in /root/WMSD/labs/lab_6/netperf_manual.pdf. Read sections 3,4,7 and 8.You will use *netperf* to measure the throughput. Alternatively, the *netperf* manual can also be obtained from http://www.netperf.org/netperf/training/Netperf.html.
- Write a script in Linux that invokes the netperf client (*netperf_client*) to transfer UDP segments for 15 seconds. Ensure that the segment size is so chosen to avoid any IP fragmentation. Save the script in the /root/WMSD/labs/lab_6 folder.
- Read the article by J. del Prado and S. Choi, "Experimental study on co-existence of 802.11b with alien devices," Proceedings of the IEEE Vehicular Technology Conference, Atlantic City, October 2001.

Part III – In-class lab assignment

We will study interference between Bluetooth and 802.11b. Students will form teams consisting of four groups (eight students). Two groups will be involved in the establishment of a Bluetooth Piconet and other two groups will be involved in the set-up of an ad-hoc network. We will study the difference in throughput for an ad-hoc connection in the presence of a Bluetooth piconet. The configuration is as shown in Figure 1:

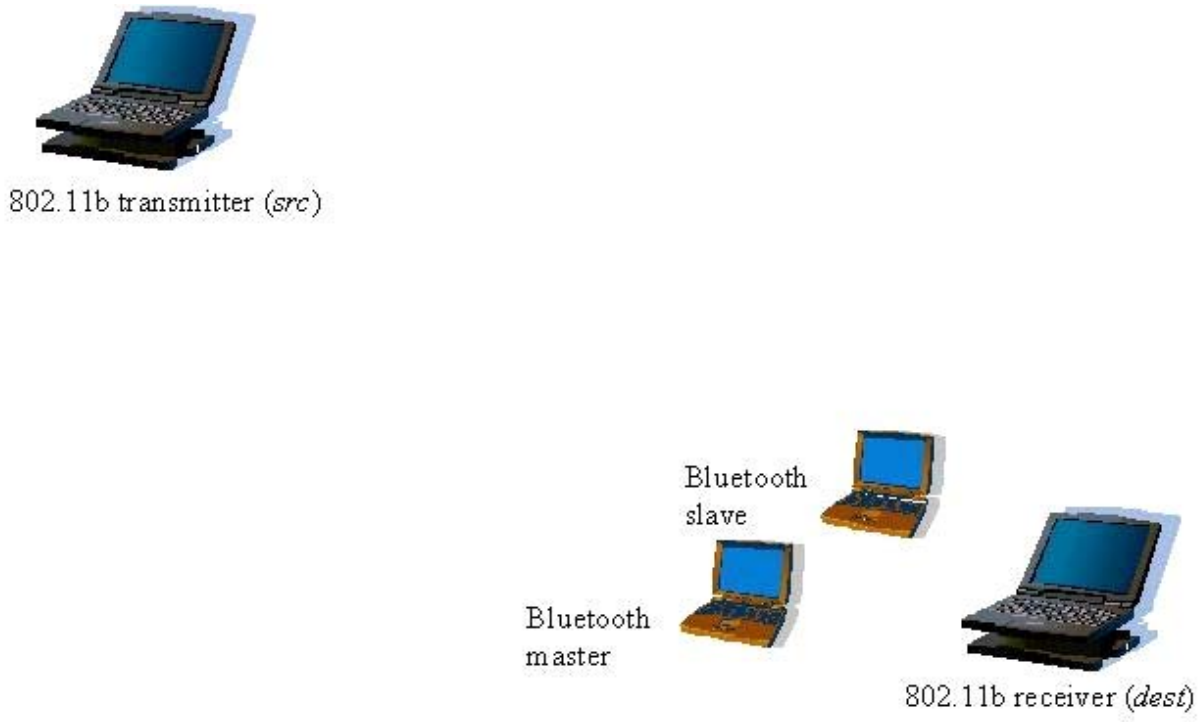

Figure 1 - Experiment Set-up.

- The first task is to set-up the experiment. For this purpose, the two groups responsible for the set-up of an ad-hoc network will form the source and the receiver of the ad-hoc link. One group will be the *src* and the other will be the *dest*.
- Boot the two notebooks in Linux with the 802.11b cards in the PCMCIA slots. Use the *iwconfig* command in Linux to set the mode of operation to Ad-Hoc, ESSID to *wmsd groupnumber* where *groupnumber* is the number of the group acting as *src*. Set the transmission power to 1mW or 0 dBm. Make a note of your settings. Set the IP address of the *src* and *dest* as 169.254.1.id_of_notebook where *id_of_notebook* is the id associated with your notebook. Set the channel of operation as assigned by the GTA to you.

- Establish an ad-hoc connection between the *src* and *dest.* Ping the *src* machine from the *dest* and capture a screen shot of the ping output, thereby validating the ad-hoc connection.

To introduce interference, we now establish a Bluetooth piconet around *dest* as shown in Figure 1.

- Start by inserting the Xircom Bluetooth cards in the notebooks. One of the groups will act as the "master" of a Bluetooth Piconet and the other group will be the "slave." After inserting the Bluetooth adapter in the PCMCIA slot, click on the "Bluetooth places" icon in the task bar. When the manager appears on your screen, check the properties of your card. This can be done by right clicking on the icon corresponding to the name of your notebook and clicking on the "Properties" button.
- The properties of the Bluetooth device include name of the device, 48-bit MAC address of the Bluetooth adapter, device class and connection profile. Ensure that the encryption is off for the connection between the communicating devices. Note the MAC address of your device.
- A Bluetooth device can be either in non-pairable mode or in pairable mode. In pairable mode the Bluetooth device accepts paring – i.e. creation of bonds – initiated by the remote device, and in non-pairable mode it does not. Set the pairable mode to "Bondable" on your device. After confirming the settings on the notebooks involved in the set up of the Bluetooth link, the group that is acting as master of the piconet should right-click on the "New" icon and click on the "Discover all" option (see Figure 2). The group acting as "slave" should right-click on the icon corresponding to the notebook name and click on the "Discoverable" icon (see Figure 3). With this, the "slave" makes itself available to be discovered by the "master." When the "slave" device is discovered, the details about it are displayed at the "master" under the "New" icon.

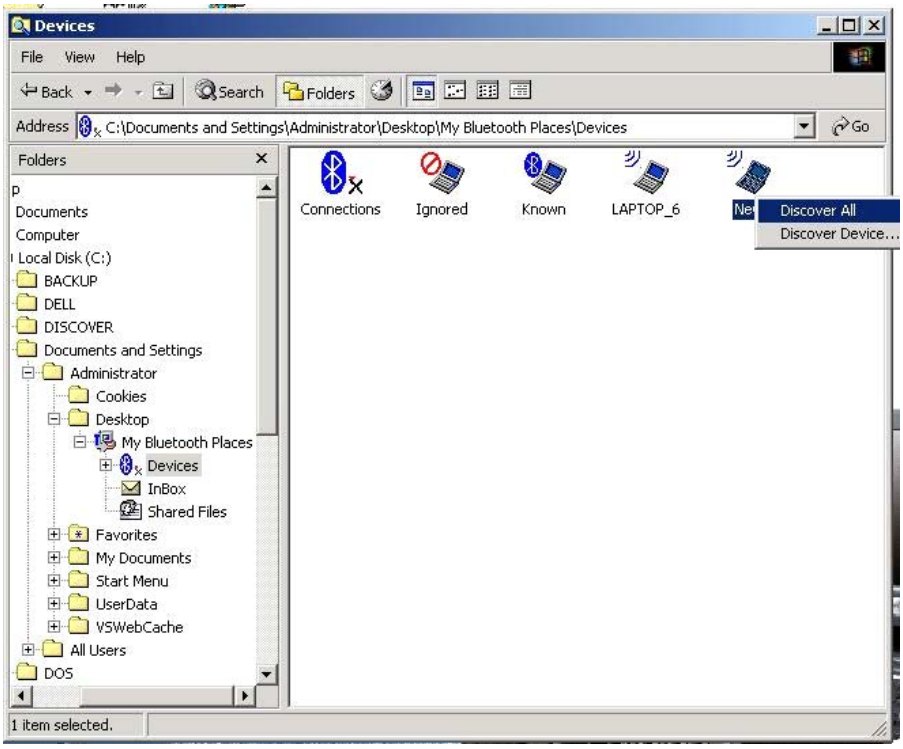

Figure 2- Snapshot of the master device's "Bluetooth places" window.

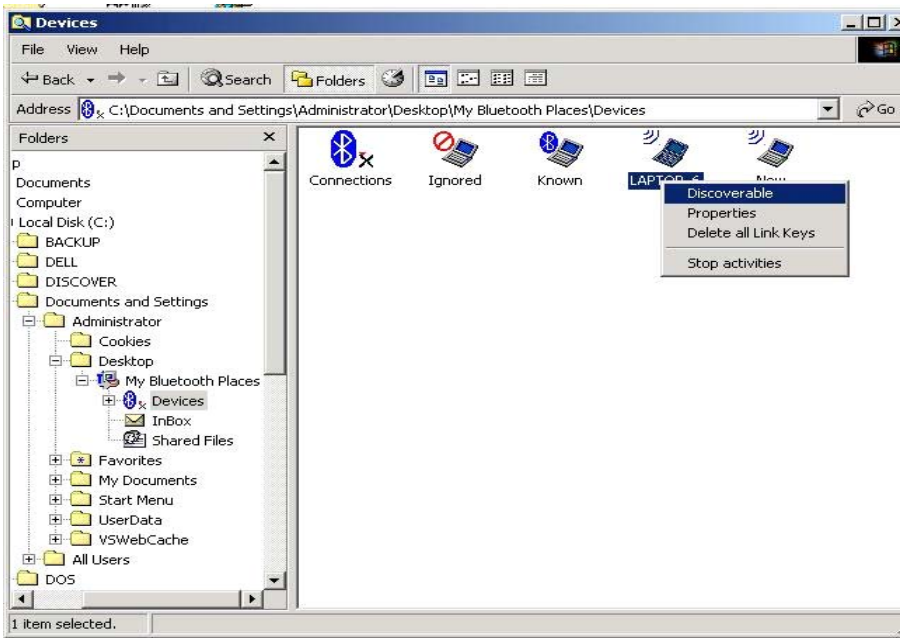

Figure 3- Snapshot of the slave device's "Bluetooth places" window.

- Double-click the "New" icon to display the discovered "slave." Double-click on the "slave" and there will be a list of profiles available on that "slave." Double-click on the

"Intellisync" profile and there will be an option of establishing a one-time or a permanent connection. Establish a permanent connection between the "master" and the "slave" such that in the event of a disconnection, the two devices will be connected again. Select the "permanent" radio button and click ok.

- One of the main applications of Bluetooth is essentially looked as a "cable-replacement" technology; it provides emulation of serial data transfer between two devices. The Bluetooth devices that you have provide the emulation of serial ports. When you use the synchronization software, Intellisync, you make use of port COM 12. You have now established a Bluetooth piconet. The set-up of the experiment is now complete.

Throughput measurements

- We will measure the throughput of the ad-hoc connection in the absence and then in the presence of Bluetooth interference using *netperf*. The *netperf* binary is located in /usr/local/netperf and is linked at /usr/local/bin, so it can be executed from any folder in Linux.
- Stop the Bluetooth radio on both, the "master" and the "slave" devices. To stop the Bluetooth radio, right-click on the  icon in the task bar and then uncheck the "Radio on" option.
- Start the *netperf* server on the *dest* node by typing *netserver* in the terminal window. *netserver* is configured to listen to connections on port 12865. Run the *netperf* client script (*netperf_client*) saved in the /root/WMSD/labs/lab6 folder by typing *./netperf_client* in the terminal window on the *src* node.
- Measure the throughput returned by *netperf* for a data rate of 1Mbps. The data rate can be varied by using *iwconfig*. The signal level can be read by typing *iwconfig* in the terminal window. Take the measurement at a signal level of -60dBm at the *src* node. Perform three such data transfers using *netperf* and note down the throughput values for each such transfer.
- Capture a screen shot of the *netperf* terminal window for the report. The screen shot should be taken for only one of the three readings of throughput. In order to take a

snapshot on Linux, click on the "K" icon in the taskbar and go to graphics>KSnapshot. Use KSnapshot to take a screen shot of the *netperf* window.

We now introduce interference in the form of a data transfer in the Bluetooth piconet.

- Start the Bluetooth radio on the "master" and the "slave" device by clicking on the red icon in the task bar, as done above for stopping the Bluetooth radio. Right - click on the same red icon in the task bar after your radio is "on" and click on "Open my Bluetooth places." When the manager appears on your screen, on the "master" device, double-click on the "Connections" icon in the left hand frame. You will see the permanent connection being displayed as shown in Figure 4 below.

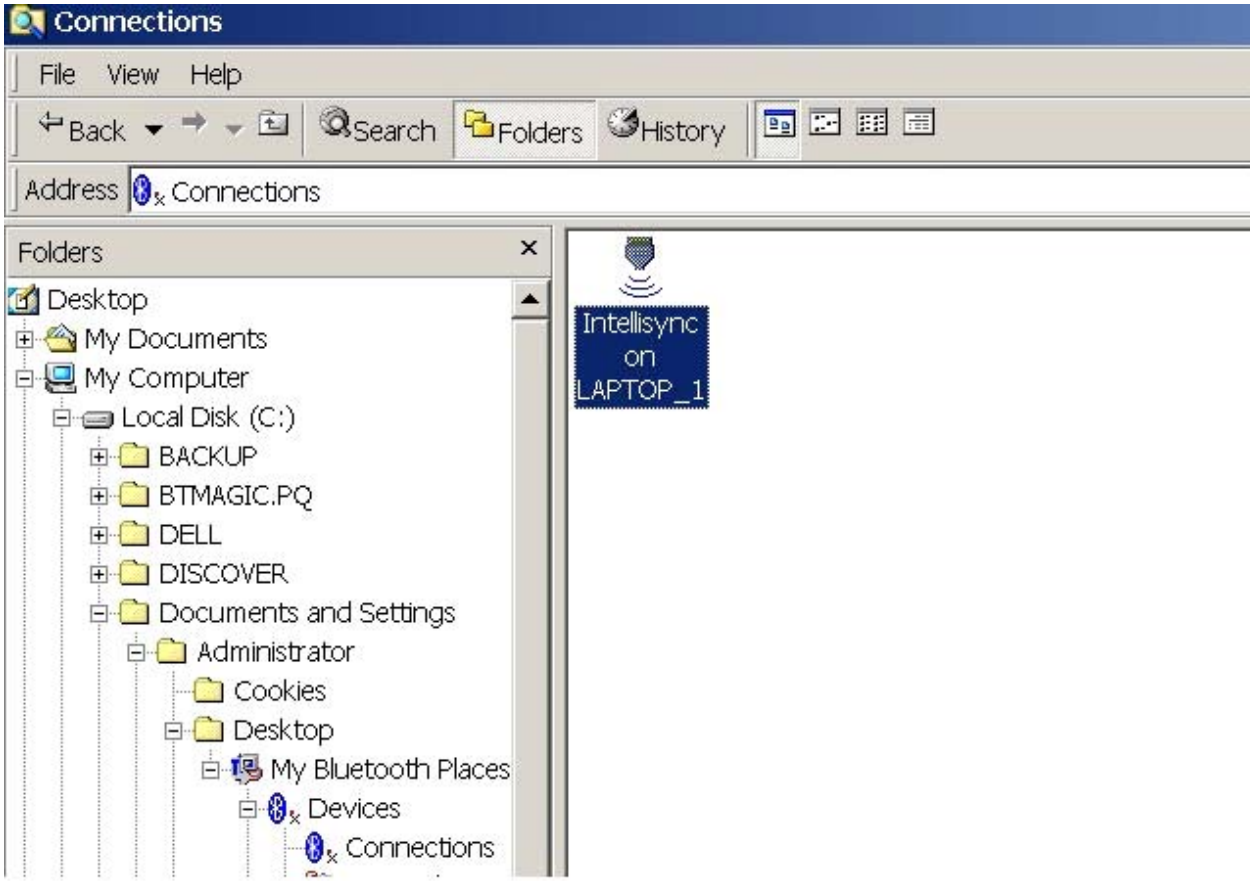

Figure 4- Snapshot of the "Connections" window under "My Bluetooth places"

- The “master” connects to the slave using Intellisync software. Start the Intellisync agent on both devices by going to Start>Programs>Intellisync>Intellisync agent. Using the Intellisync agent on the desktop, select ‘File Transfer’ icon on both the notebooks as shown in Figure 5.

Figure 5- Snap shot of the Intellisync agent

- A connection will be established between the two Bluetooth devices with an accompanying sound. A security window will appear on the screen if the connection is being established for the first time. Under this security setting, select the “Security” tab and allow the remote user to access your inbox only. Select the “Inbox transfer only” button as shown in Figure 6.

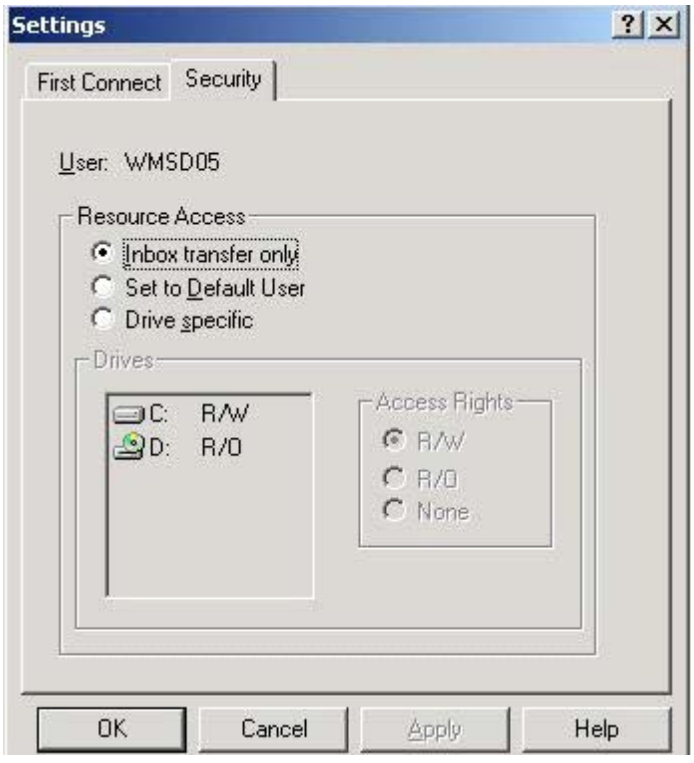

Figure 6- Snap shot of the security settings for Intellisync

- In order to start the data transfer, on the "slave" system, select the file "pockettvsetup-0.9.4.exe" in C:\WMSD\iPAQ and start its transfer to the "master" device. The file can be chosen from the right-hand side explorer window. Right click on the file and select the "master" as shown in Figure 7.

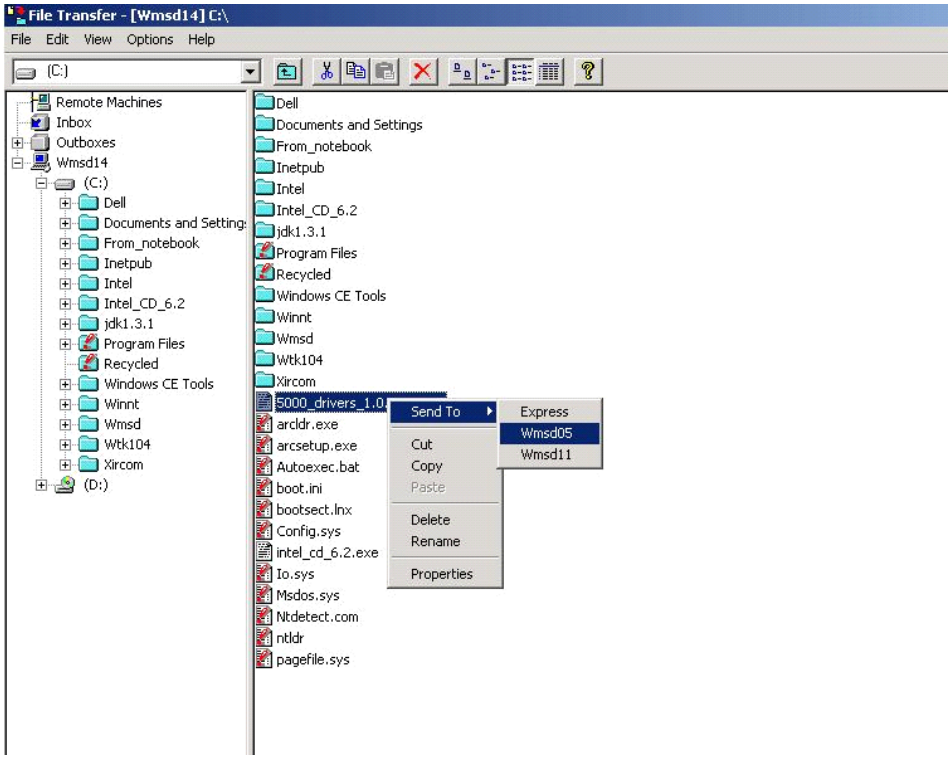

Figure 7- Snap shot of the File transfer explorer window.

- Here, Bluetooth interference is present in the form of data transfer between two devices. Now measure the throughput of IEEE 802.11b connection using *netperf*. Start the *netperf_client* at the *src* and measure the throughput. While you measure the IEEE 802.11b throughput, ensure that the Bluetooth devices are transferring data. Perform three such data transfers using *netperf* and note down the throughput values for each such transfer.

- Report the throughput for the adhoc connection. Capture a screen shot of the *netperf* terminal window, to be included in this week's report. The screen shot should be taken for only one of the three readings of throughput. In order to take a snapshot on Linux, click on the "K" icon in the taskbar and go to graphics>KSnapshot. Use KSnapshot to

take a screen shot of the *netperf* window. Also take a snapshot of the Bluetooth data transfer.

Note: While transferring Bluetooth data for different data rates, delete the file being transferred after it is transferred to the "master" device and re-transfer the same file for different data rates.

- Repeat the above procedure of throughput measurements for different IEEE 802.11b data rates of 2Mbps and *auto*. Do this in the absence and in the presence of a Bluetooth connection. In order to change the data rate of the ad-hoc connection use *iwconfig.*

  Note: *auto* data rate means that the IEEE 802.11b link will try to maintain a theoretical bandwidth of 11Mbps; however it may reduce to a bandwidth less than 11Mbps, depending on current channel conditions.