Investigation of WLAN

Laboratory measurements

1. The measurement setup

The measurement setup is shown Figure . The setup consists of three personal computers with WLAN interface cards. The names of the personal computers in Figure are according to the naming of computers used in Communications laboratory. The connections between the equipment are wireless links conforming to IEEE 802.11b standard. Buffalo WLI-PCI-G54 and has D-Link AirPlus G DWL-510 cards are used for connecting the computers in ad-hoc mode. The cards are already installed inside the personal computers. The WLAN antennas of the cards are connected to the antenna sockets at the rear of the computers.

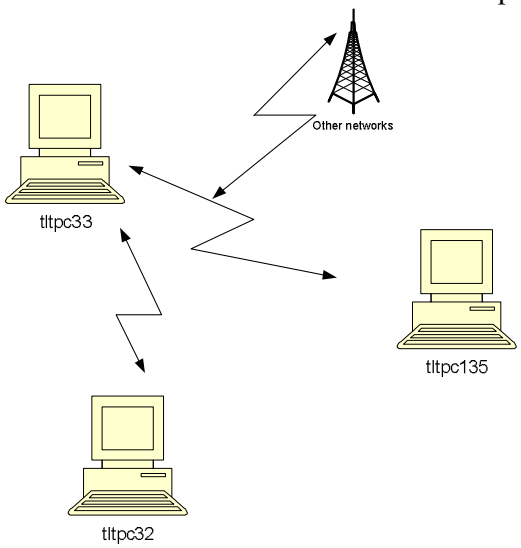


Figure 1. The equipment used in the laboratory work.

1.1 Equipment

The personal computer TLTPC33 is equipped with Buffalo WLI-PCI-G54 WLAN card. TLTPC32 has D-Link AirPlus G DWL-510 card. TLTPC135 has both cards and you can use either of them. The cards are set to operate using IEEE 802.11b standard. All the wireless devices should be located at the visible range of each other. This is because the attenuation and other propagation effects are wanted to be minimized. In the measurements it is also more convenient to have the two computers next to each other. The IP addresses and equipment names can be shown in Table .

Table 1 IP addresses associated with the measurement equipment.

Equipment	IP address
TLTPC33	10.0.0.1
TLTPC32	10.0.0.3
TLTPC135	10.0.0.2

1.2 Software

The software needed for the laboratory work is installed to the personal computers. The programs presented in following sub-sections are installed to the computers and a link to them is found on the desktop of each computer:

1.2.1 Iperf version 1.7.0

This program is used for generating packets of defined length and at certain bit rates over the wireless link. The program requires that it is running at both ends of the connection. This means that Iperf has to be running in both TLTPC33 and TLTPC32. In this laboratory work TLTPC33 will work as the client and TLTPC32 as the server. In this laboratory work only the client will send packets.

1.2.2 Network Stumbler 0.4.0

This program is used for monitoring all the WLAN networks visible for the wireless device. This program reports also signal levels and the Signal to Noise Ration (SNR). The radio channel usage can be easily monitored using this program.

2 Laboratory Work Instructions

2.1 Preparation for the laboratory works

First locate all the devices shown in Figure . Turn on the computers and log on to them, as instructed by the assistant.

Disable the Wlan interfaces and set the IP addresses in all the computers.

For that you have to open the “Network connections” panel from the “Start” -> “Control panel”

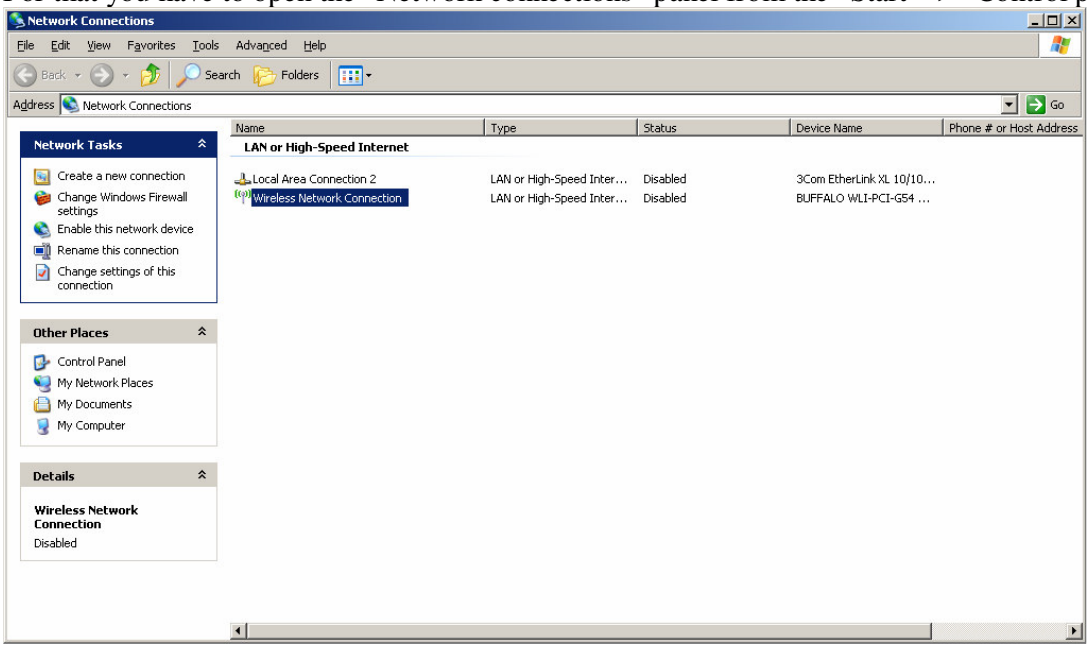


Figure 2. “Network connections” panel.

For disabling the network connection you can click with right mouse button on the Wireless network connection and select from the opened menu “disable”.

For changing the IP you can open from the right options column “Change setting in this connections”. From the opened menu select the “Internet Protocol” (see Figure 3) and select “Properties”. From opened menu set the corresponding IP address and the subnet address to “255.255.255.0”. (see figure 4).

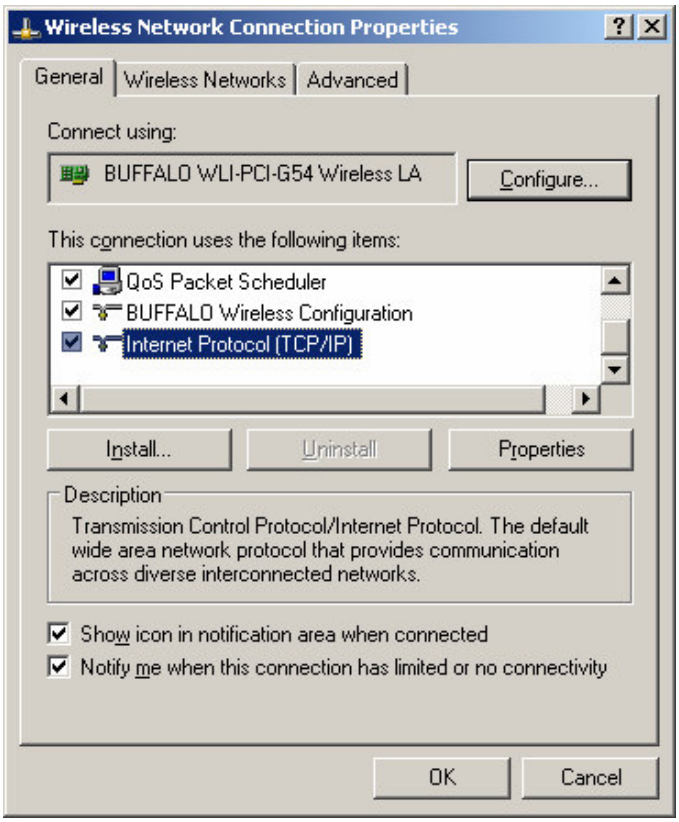


Figure 3. “Wireless Network Connection Properties”.

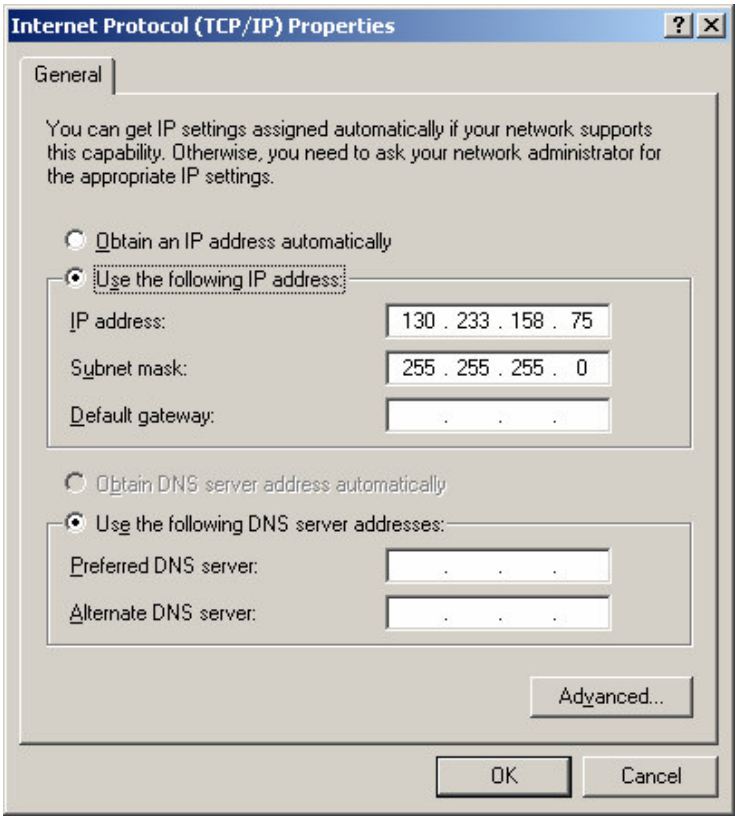


Figure 4. “Internet protocol properties”.

2.2 Create an Ad-Hoc type subnet work

Set the channel in TLTPC33. For that you have again to open the “Change setting in this connections”. Open configure menu and from the Advanced settings menu set the IBSS Channel number to be required number (in different stages of the laboratory work you need different channels) initially you can set it to be 1.

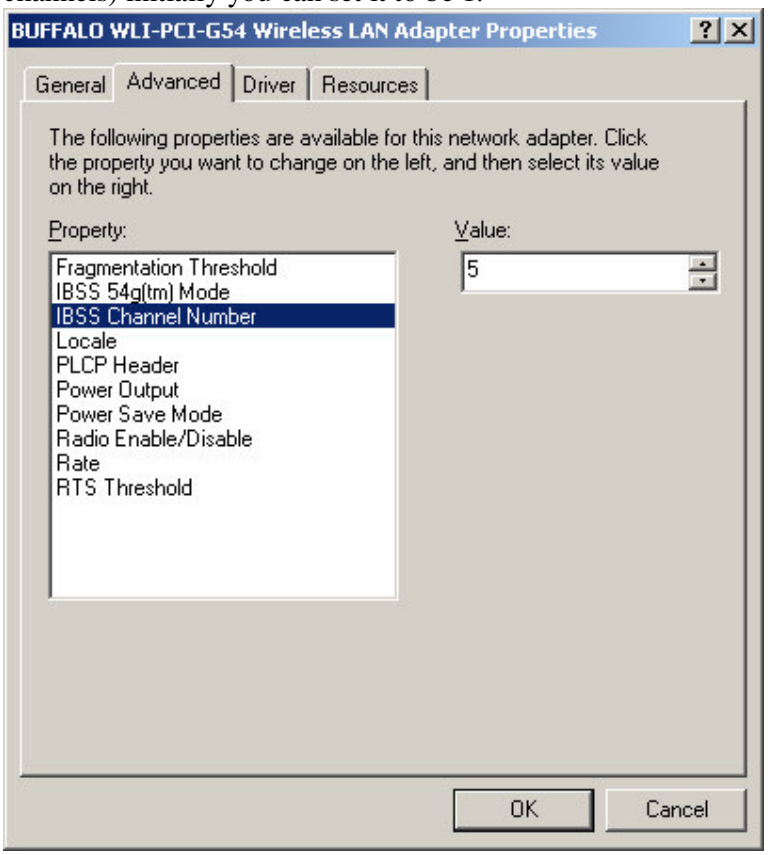


Figure 5. Setting Ad-Hock network channel number.

Create in TLTPC33 a sub-network WlanLab. For that enable the connection and from the properties of the connection (this can be opened also from the selection of “Change setting in this connections” as above) select menu “Wireless Networks”

Clean all the existing Networks from the preferred network lists (Figure 7).

Add a new network: for that select button “add” and in the opened window (Figure 8). Name the network and set the authentication be shared and disable data encryption.

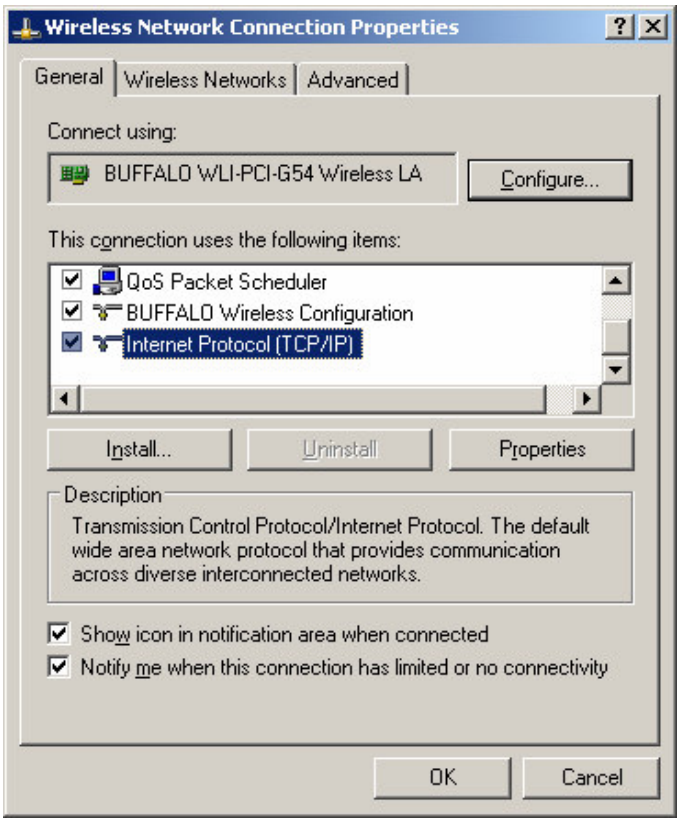


Figure 6. “Wireless Network Connection Properties” in case the network connection is enabled.

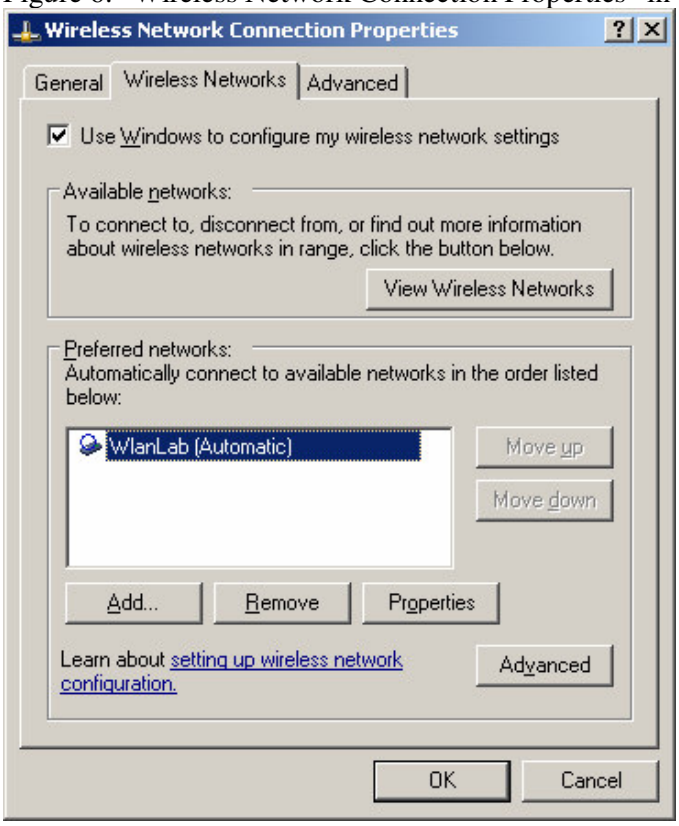


Figure 7. Setting up a new preferred network.

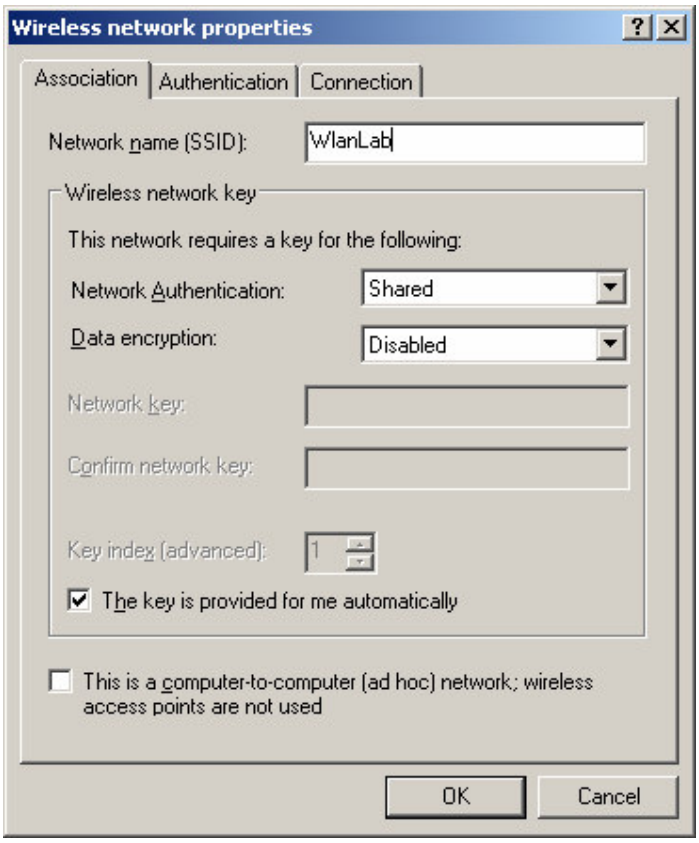
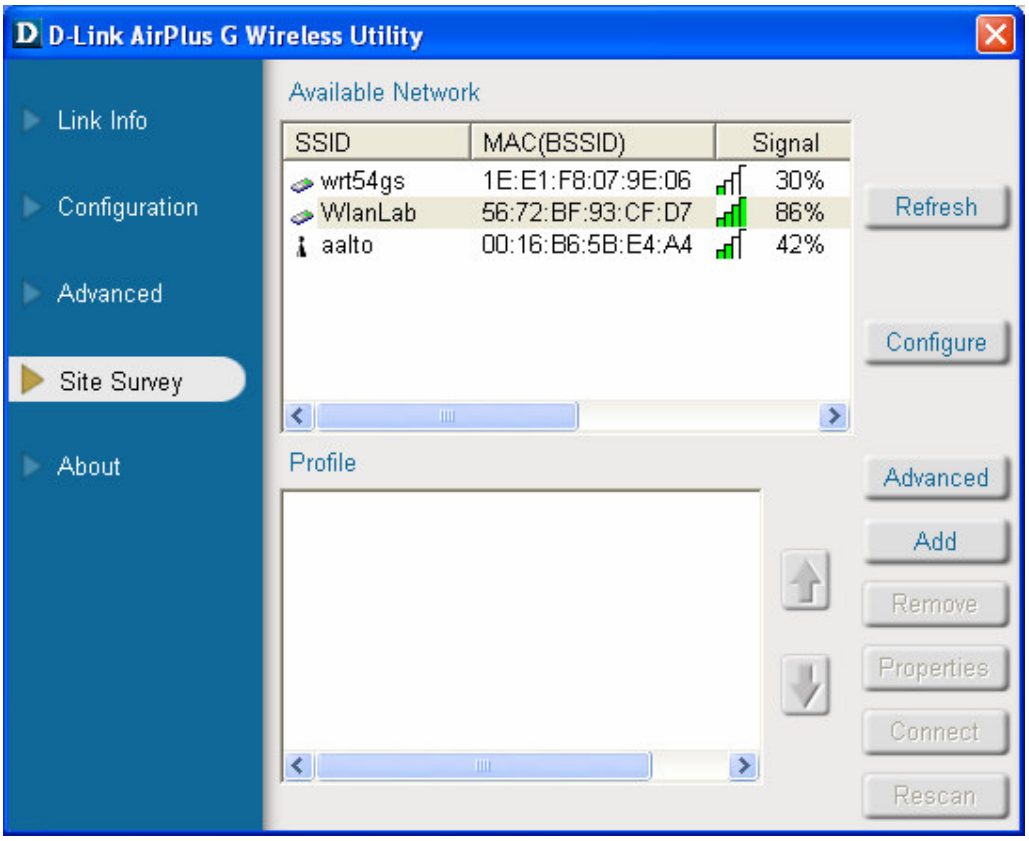


Figure 8. Now the TLTPC33 should indicate that the Wlan is connected (enabled). If it is not connected, disable and enable it again.

2.3 Connecting other computers to the created network

You can connect a computer to the network in multiple ways. For example in computer TLTPC32 enable the Wlan connection. For that you have to click with the right mouse button on the "Wireless network connections" and select enabled. From the same menu run also command "Scan for available networks". Now you just created WlanLab should become visible: connect to it.

Check whether the connected network has a correct channel. For that you can start "Network stumbler". Together with it starts also "D-Link AirPlus G Wireless Utility". Refresh the "Site Survey" and scroll right to check the channel of the WlanLab network.



Check whether the connection works. Operate now just on TLTPC33. Start the Command Prompt by clicking its icon on the desktop. Make a PING test to the TLTPC32 using information in Table : write “ping 130.233.158.92” in the Command Prompt. If the IP address 130.233.158.92 replies, the connection is okay.

2.4 Laboratory measurements

1. Finding the correct radio channel

The system is now up and running. If the AP would be connected to the LAN of the laboratory, you could use the Internet. Consider that you would like to make your own WLAN. Knowing that several things can interfere with the IEEE 802.11b (Section **Error! Reference source not found.**) you must find the best channel for your AP to operate on. After all you don’t want your Internet connection to be slow.

The suitable radio channel is found by selecting one radio channel at a time by changing the radio channel of the WlanLab network (in the TLTPC33) and measuring each channel using Iperf as instructed in Section 1.2. Iperf will output the total amount of data sent “bandwidth” (a more proper term would be data rate), delay variation (also called as jitter) and packet loss rate (in percentages) results. Write down the results for data rate (for both client, TLTPC33, and server, TLTPC32), jitter and packet loss rate. Choose the length of the packet to use with Iperf, on the basis of the pre-laboratory work so, that the measured throughput will be the maximum. The sheet for the measurement results is in APPENDIX A.

1.1 Changing the radio channel

To measure the WLAN network operating on different radio channels, the radio channel of the ad-hock network has to be changed. For that:
Disable wireless connection in all the computers.
Change the channel in the TLTPC33. (accordingly to instructions related to Figure 5 above).
Enable the connection in TLTPC33.
Enable the connection in other pc:s, and connect them to WlanLab network.
Check whether the channel used by WlanLab network is the one you set it to be.

1.2 Using Iperf for the measurements

Iperf documentation can be found in [Ipe04]. Iperf has to be running in both TLTPC33 and TLTPC32 (or TLTPC135) . By using the commands listed in Table 1 you can send UDP packet having Service Data Unit (SDU) length defined by parameter "-l". The initial value for the parameter "-l" in Table 1 is 1470. This is the maximum length UDP SDU that can be sent without fragmentation, even though WLAN standard would allow longer MAC frames. The Iperf has to be running on both computers, on TLTPC32 as a server and on TLTPC33 as a client. The length of UDP SDU length has to be set the same on client and server. If the server fails to report its data rate, jitter and packet loss rate values to the client (TLTPC32) in some part of the measurements, you have to look the results from the server's (TLTPC33) monitor to get the results to Table . Normally, all the results are available from the client's monitor.

Table 1 Commands for using Iperf to generate traffic to the WLAN network

Operation	Command
Start the Iperf receiver in TLTPC32	iperf -s -l1470 -u
Start the Iperf client in TLTPC33	iperf -c 130.233.158.75 -l1470 -u -b 11M -n14700000

2. Measuring the signal strength of the channels

Open "Network Stumbler" in the computer TLTPC135.
Measure signal strength of all the visible networks, measurement length could be around 10 s. Take a print screen and insert the result in to a file. Include the file into you final report.
Repeat the measurements by disconnecting the outside antenna.
Describe how the signal strength is changed?
Look at the list of used radio channels and make a note for the post laboratory work about how the measurements in 1 correlate with the report of Network Stumbler.

3. Measuring the effect of packet length to capacity, packet errors and delay variations of the network

Establish a connection between the computers over the cable. Set the attenuation in the variable attenuator to be minimum. Configure your ad-hoc network to use channel 5. After setting the connection you can use Iperf to measure the effect of packet lengths to the maximum throughput, packet errors, and delay variations. For this measurement the "-l" parameter has to be altered between the measurements. Remember to keep the UDP SDU lengths the same in both Iperfs running on client and server. Write the results to 3 in APPENDIX B.

4. Measuring the effect of signal strength to the packet errors and delay variations

Use the same connection as in 3. Select UDP SDU length that gave highest throughput in the measurement in 3. Start to increase the attenuation in the channel and measure how it impact the throughput.

5. Post-laboratory work

The post-laboratory work format is a document that includes: cover page, table of contents, introduction, measurement results and conclusions. Draw curves of 3 and 4. Explain your discoveries of the measurement results and their relation to the pre-laboratory work.

APPENDIX A

Table 2 Table for the measurement results in finding the correct radio channel.

Channel	Client data rate	Server data rate	Jitter	Packet loss rate
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

APPENDIX B

Table 3 Measurement table for packet length measurements using the best radio channel.

Measurements for channel:				
UDP SDU length	Client data rate	Server data rate	Jitter	Packet loss rate
100				
300				
500				
700				
1000				
1300				
1470				

Table 4 Measurement table for packet length measurements using the worst radio channel.

Measurements for channel:				
UDP SDU length	Client data rate	Server data rate	Jitter	Packet loss rate
100				
300				
500				
700				
1000				
1300				
1470				