Virginia Tech ■ ECE/CS 4570: Wireless Networks and Mobile Systems ■ Spring 2006

At-home Exercise 6 (E06)

Report Due: March 2, 2005 (at 4:00 PM)

Part I – Objectives and Laboratory Materials

Objective:

The objective of this exercise is to:

❑ Analyze the effect of interference created by a Bluetooth piconet on the performance of an IEEE 802.11b network.

After completing the assignment, you should be able to:

❑ Suggest techniques to mitigate the interference of Bluetooth on IEEE 802.11b.

Part II – At-home Laboratory Assignment

Using the results obtained from the in-class laboratory, you are to perform the following tasks:

❑ Take the average of the three throughput readings for the ad-hoc IEEE 802.11b link in the absence of any Bluetooth interference and in the presence of Bluetooth interference for each data rate setting (1 Mbps, 2 Mbps, and "auto").

❑ On one bar graph plot:

(a) The average of the measured throughput values for the ad-hoc IEEE 802.11b link established in the absence of any Bluetooth device for the three different data rate settings (1 Mbps, 2 Mbps, and "auto"); and

(b) The average of the measured throughput values for the ad-hoc IEEE 802.11b link established in the presence of a Bluetooth Piconet for the three different IEEE 802.11b data rate settings.

The *x*-axis should indicate the data rate and whether or not interference is present. The *y*-axis should indicate throughput.

❑ Calculate the theoretical throughput at the MAC layer expected for an 11 Mbps IEEE 802.11b PHY layer data rate. Assume the following.

- Data is transferred in the form of UDP datagrams with an MTU of 1500 bytes
- The DIFS time is 50 µsec
- The SIFS time is 10 µsec
- The minimum contention window length is 31 slots
- The slot time is 20 µsec
- The TPLCP preamble is 144 µsec
- The TPLCP header is 48 µsec

Note that in the 802.11b protocol, the data rate for ACK frames is 2 Mbps, even if data frames are sent at 11 Mbps. Use the formula given in the paper in your reading assignment for calculating the throughput.

Part III – Report

This report will cover both in-class and take-home components of this week's assignments. The report will be graded for both form and content. The report must be submitted in electronic form to the Dropbox on the Blackboard site for this course. Adhere to the submission guidelines provided earlier in the semester. Each group must submit one report for the entire group.

Provide a report that answers each of the following questions in the order list here.

Part I – In-class Experiments and Analysis

1. Experiments with the Bluetooth piconet

   (a) What is the MAC address of the Bluetooth adapter used in the experiment?

   (b) What are the other application profiles available for Bluetooth?

2. Experiments with Bluetooth and 802.11b interference

   (a) Include the three screen shots taken during the class: (i) the *ping* output, (ii) the *netperf* output showing thoughput at 1 Mbps without interference, and (iii) the *netperf* window showing throughput at 1 Mbps with interference.

   (b) Include the bar graph containing the throughput results.

3. Discussion of results

   (a) Discuss your results and provide conclusions. Is there significant interference between Bluetooth and 802.11b?

   (b) Present your calculation of the theoretical throughput of IEEE 802.11b with a PHY data rate of 11 Mbps. Why is the theoretical throughput less than PHY data rate of 11 Mbps? Explain the role of SIFS and DIFS and how these and other factors reduce the theoretical throughput.

   (c) Is the measured throughput at data rate setting "auto" less than the theoretical throughput that you calculated above? Why?

   (d) How can we reduce the effect of interference of Bluetooth on 802.11b? Suggest at least two techniques.

Part II – General Conclusions

This is the free-form portion of your report. Provide a summary of lessons learned in this assignment, general observations on how each of the tools illustrated by the experiments can be used to configure and assess performance of the network, any unexpected results obtained, etc. Feel free to suggest improvements to the experiments performed in this week's laboratory.