Virginia Tech ■ ECE/CS 4570: Wireless Networks and Mobile Systems ■ Spring 2006
At-home Exercise 13 (E13)

Report Due April 27, 2006 at 4 p.m.

Part I – Objectives and Lab Materials

Objectives:

The objectives of this at-home assignment are to:

- Understand the design concept of "broadcast-disks" for providing broadcast-based data services; and
- Experiment with broadcasting hot/cold data items based on the concept of "broadcast disks."

After completing the assignment, you should be able to:

- Use Visual C# and UDP programming to realize broadcast-based data service applications; and
- Quantitatively analyze the response time behavior of broadcast-based applications.

Hardware to be used in this at-home assignment:

- Dell notebook computer with IEEE 802.11b card
- HP iPAQ with IEEE 802.11b card, dual-card sleeve, and cradle
- Intel Wireless Gateway

Software to be used in this at-home assignment:

- Notebook computer: Windows operating system; Microsoft Visual Studio .NET; server software from this week's in-class laboratory
- iPAQ: Pocket PC operating system; client software from this week's in-class laboratory

Part II – At-home Lab Assignment

You are expected to perform the following tasks:

1. Read S. Acharya, R. Alonso, M. J. Franklin, and S. Zdonik, "Broadcast disk: data management for asymmetric communications environments," *ACM SIGMOD International Conf. on Management of Data*, 1995, pp. 199-210 (at http://citeseer.ist.psu.edu/45388.html or http://portal.acm.org/citation.cfm?doid=223784.223816).
2. Design a broadcast disk organization system based on the "broadcast disk" concept satisfying the following specifications.
    a. The total number of data items is 1000, of which items 1 through 200 (C000-C199) are "hot" data items and items 201 through 1000 (C200-C999) are "cold" data items.
    b. Hot and cold data items are to be broadcast based on the access probability ratio between hot data and cold data being 4:1.
    c. Each item being broadcast is of the following format: a 4-byte stock symbol of type character in the form **Cddd** followed by a tab character ("\t"), followed by a 4-byte price of type character in the form of **dd.d** or **d.d**. where **d** is a decimal digit, 0-9.
    d. Consecutive data items are separated by the "|" character.

e. A UDP packet of size 1000 bytes is used to hold 100 items at a time.

f. The broadcast channel bandwidth is approximately 80 Kbps.

g. No cache is used on the client side. Whenever an item is needed, the client must tune to the broadcast channel to retrieve the item.

2. Open Server.sln under c:\wnms\labs\lab_11 folder. Modify Class1.cs under project "bcaster" for implementing the "broadcast-disk" organization and data broadcast functions.

   Use PPCClient to measure the average response time of hot data items (called it "R-hot") and the average response time of cold data items (call it "R-cold").

   First, specify the number of clients in the text box "Stock Symbol or Query Number." A measure of the average response time can be obtained by pressing the "Hot Data" button which triggers hot data symbols in the range of [0, 199] to be automatically generated and their average response time computed and displayed in the display screen.

   Repeat the same procedure to compute the average response time for cold data items. Use three trials and calculate the average response times for R-hot and R-cold from the three trials for each. The weighted *average* response time per data item, regardless of data types, can then be calculated manually using the following formula.

$$\text{Average response time} = 0.8 \times \text{R-hot} + 0.2 \times \text{R-cold}$$

Part III – Report

This report includes both in-class and take-home components of this week's assignments. You must turn in a report containing the following items in the order specified. Follow the established guidelines for reports.

Part I – In-class experiments

- Report stock prices returned by the broadcast-based data service for the following stock symbols.
  - C234
  - C125
  - C640
- Report the average response time versus the number of clients, *N*, for both the broadcast-based and traditional client-server data services.
  a. Report the two tables collected in the in-class laboratory session.
  b. Draw a diagram comparing the two data services applications with the *x*-axis representing the number of clients, *N*, and the *y*-axis representing the average response time (ms).
- Give your conclusions about the sensitivity of the response time metric with respect to the number of clients, *N*, for the broadcast-based and traditional client-server data service schemes. Give an explanation of your results. Which of the two schemes will give a better response time when *N* is sufficiently large (say 100)? Note that UDP is being used for broadcast-based data services, while TCP with multiple threads is being used for the traditional client-server data services.

Part II– At-home experiments

- Give the broadcast-disk organization for broadcasting "hot" and "cold" data items using the same notation as in the broadcast disk paper by Acharya, *et al.* in the reading assignment.

- Show a listing of the source code in the modified Class1.cs file and a brief description of the part modified.
- Report the weighted average response times collected by your program for hot data and cold data, separately, as well as the overall average response time per data item, regardless of the data type.
- Compare the overall average response time per item obtained from the "broadcast disk" organization used in the at-home exercise and the average response time obtained from the "flat" data organization used in the in-class laboratory session. Which method provides a lower response time? Explain.

Part III: Other information

- This is the free-form portion of your report. Provide a summary of lessons learned in the in-class and take-home experiments. Report any experiment problems if any. Feel free to give us any suggestions and/or comments on this week's assignments.