Elec/Comp 526
Spring 2018
Project 4A: Storage Array

This assignment deals with the performance study of a simplified storage array. The array consists of several independent solid-state disks (SSDs) fronted by a storage array buffer that holds pending requests in a logically shared request pool. Each disk services its pending requests in the buffer in FCFS order.

Read and write requests have a fixed service time of READ_SERVICE_TIME and WRITE_SERVICE_TIME (ms) respectively. The number of disks is specified by NUM_DEVICES and the size of the buffer is MAX_STORAGEQ requests.

The SSD IOPS (IOs per second) capacity depends on the mix of reads and writes in its workload. In our (simplified) model we assume that read and write requests have a fixed service time denoted by READ_SERVICE_TIME and WRITE_SERVICE_TIME (ms) respectively. If f denotes the read fraction, the average IO request service time t (ms) is:

$$t = f * READ\_SERVICE\_TIME + (1-f) * WRITE\_SERVICE\_TIME$$

If all disks are working continuously the system throughput is :

$$System\ Throughput = NUM\_DEVICES * 1000 / t$$

In this portion of the assignment we use a single closed-loop client to generate the workload requests. The client always keeps a fixed number of requests outstanding in the system: this is the number of requests in its client queue plus the requests in the array buffer waiting for service at a device. The number of outstanding requests of the client is specified by the constant NUM_OUTSTANDING_REQUESTS.

If the client has not reached the maximum number of outstanding requests, it adds a request to the tail of it FCFS client queue. The scheduler moves requests from the client queue into the array buffer when there is space in the buffer. Requests in the buffer are served independently by each device in the order of their insertion into the buffer.

Details
The project files are available on CANVAS as "project4A.tar.gz".

The trace file is generated using maketrace.c. Compile maketrace.c and execute to create the trace file memtrace. The trace file will need to be re-generated when the read/write ratio of the workload is changed. The fraction of reads in the trace file is determined by the constant READ_FRACTION in global.h.

The simulation program is obtained by compiling the file sim.c along with precompiled object files utils.o and yacsim.o, as described in the README file. The simulation parameters including NUM_OUTSTANDING_REQUESTS can be changed by editing global.h.

Experiment and Report

Experiment 1

MAX_STORAGEQ	120
READ_FRACTION	1.0
STRIPED	TRUE

NUM_OUTSTANDING_REQUESTS Vary (a) between 1 and 10 in steps of 1 and (b) between 10 and 170 in step of 20

Fixed Parameters:

NUM_DEVICES	8
READ_SERVICE_TIME	0.1 (ms)
WRITE_SERVICE_TIME	0.4 (ms)

I. Vary NUM_OUTSTANDING_REQUESTS as noted above and record the system throughput and response time in each case.

II. Change STRIPED to FALSE and repeat Step I.

III. Graph the System Throughput vs NUM_OUTSTANDING_REQUESTS for both I and II on the same plot.

IV. Graph the Response Time vs NUM_OUTSTANDING_REQUESTS for both I and II on the same plot.

V. Explain your results: the shapes of the individual throughput curves and the comparison between them. Do the same for the response time curves. Submit two plots and explanation for Experiment 1.

Experiment 2

V1. Repeat Experiment 1 for different values of the READ_FRACTION.

Use the following values of READ_FRACTION: 1.0, 0.75, 0.5, 0.25, 0.0. Keep STRIPED as FALSE in all the experiments. Make sure to generate a new trace file whenever the fraction changes.

(a) Graph the System Throughput vs NUM_OUTSTANDING_REQUESTS on the same plot for each value of READ_FRACTION.

(b) Graph the Response Time vs NUM_OUTSTANDING_REQUESTS on the same plot for each value of READ_FRACTION.

(c) (c) Plot the ratio of the Read Throughput to Write Throughput vs NUM_OUTSTANDING_REQUESTS on the same plot for each value of READ_FRACTION.

(d) Plot the ratio of the Read Response Time to Write Response Time vs NUM_OUTSTANDING_REQUESTS on the same plot for each value of READ_FRACTION.

VI. Explain your results. Explain the shapes of the individual throughput (part a) and response curves (part b) and the comparison between them. Explain the plots of part c and part d.

VII. Submit four plots and explanation for Experiment 2.