

DiskSim Project

Week Two

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Abstract—This project is to have a better understanding of storage systems with the tool of DiskSim, especially disk storage systems. And the whole project will be divided into four parts to complete.

I. Overview

DiskSim is an efficient, accurate, highly-configurable disk system simulator originally developed at the University of Michigan and enhanced at CMU to support research into various aspects of storage subsystem architecture.

A. Background

It is written in C and requires no special system software (just basic POSIX interfaces). DiskSim includes modules for most secondary storage components of interest, including device drivers, buses, controllers, adapters, and disk drives. DiskSim also includes support for a number of externally-provided trace formats and internally-generated synthetic workloads, and includes hooks for inclusion in a larger scale system-level simulator.

B. Usage

It has been used in a variety of published studies (and several unpublished studies) to understand modern storage subsystem, to understand how storage performance relates to overall system, and to evaluate new storage subsystem.

C. Structure

There are two main executable file in the whole system . One is Disksim.c and another is Sysstim_driver.c.

1) **Disksim**: There are five parameters for this function, including the: parfile, outfile, tracetype, tracefile, synthgen.

Parfile: aka parameter file. DiskSim can be configured via the parameter file to model a wide variety of storage subsystems. It uses libparam to input the parameter file.

Outfile: The output of simulation. It can be modified by the parameter file.

Tracetype: The type of trace file. ASCII, HPL, HPL2, DEC, RAW, VALIDATE, EMCSYMM, DEFAULT(ASCII) and so on. You can also add new type.

Tracefile: The format of the tracefile is request arrival time, device number, block number, request size, request flags. Zero means generating data by parameter file. If it's zero,

synthegen must be larger than zero.

synthgen: The value of synthgen means how many generators used to get trace, one generator represents a process to generator input.

2) Sysstim_driver:

disksim provides disksim_interface.c to make disksim as subsystem to get result by external requests . And this function is to use this interface to simulate the disk.

II. Case Study

A. Configuration and Installation

We run DiskSim-4.0 on 32-bit Ubuntu 14.04 LTS.

1) Download disksim-4.0.tar.gz from <http://www.pdl.cmu.edu/DiskSim/>

2) Run the commands `tar xzf disksim - 4.0.tar.gz` and `cddisksim - 4.0` in the terminal.

3) In `memsmodel/Makefile`,

repalce

```
ems_seektest: mems_seektest.o libmems_internals.a  
$(CC) -o $@ mems_seektest.o $(LDFLAGS) $(CFLAGS)  
-lmems_internals
```

with

```
ems_seektest: mems_seektest.o libmems_internals.a  
$(CC) -o $@ mems_seektest.o $(CFLAGS) -lmems_internals  
$(LDFLAGS)
```

4) In `src/Makefile`,

repalce

```
LDFLAGS = -lm -L. -ldisksim  
$(DISKMODEL_LDFLAGS) $(MEMSMODEL_LDFLAGS)  
$(LIBPARAM_LDFLAGS) $(LIBDDBG_LDFLAGS)
```

with

```
LDFLAGS = -L. -ldisksim  
$(DISKMODEL_LDFLAGS) $(MEMSMODEL_LDFLAGS)  
$(LIBPARAM_LDFLAGS) $(LIBDDBG_LDFLAGS) -lm
```

5) Run the command `make` in the terminal.

6) Run the command `cd valid; ./runvalid` in the terminal.

B. Parameter initialize

In the `disksim_logorg` org0:

Addressing Mode = Array

Distribution scheme = Striped
 Redundancy scheme = Striped
 devices = [disk0..disk8]
 In the disksim_synthio Synthio:
 change distribution to normal

C. Run

In the valid folder, run:

```
../src/disksim synthraid0.parv synthraid0.outv ascii 0 1  

grep "IOdriver Response time average" synthraid0.outv
```

D. Result:

IOdriver Response time average : 19.438945

III. Raid5

A. Parameter initialize

```
#component instantiation  

instantiate [ statfoo ] as Stats  

instantiate [ ctrl0 .. ctrl4 ] as CTRL0  

instantiate [ bus0 ] as BUS0  

instantiate [ disk0 .. disk4 ] as HP_C3323A  

instantiate [ driver0 ] as DRIVER0  

instantiate [ bus1 .. bus5 ] as BUS1
```

```
disksim_logorg org0{  

  Addressing mode = Array  

  Distribution scheme = Striped  

  Redundancy scheme = Parity( )rotated  

  devices = [ disk0 .. disk4 ]  

  ...  

}
```

```
disksim_synthgen{ # generator0  

  Storage capacity per device = 8224032  

  devices = [ org0 ],  

  Blocking factor = 8,  

  Probability of sequential access = 0.2,  

  Probability of local access = 0.4,  

  Probability of read access = 0.66,  

  Probability of time-critical request = 0.1,  

  Probability of time-limited request = 0.3,  

  Time-limited think times = [ normal, 30.0, 100.0 ],  

  General inter-arrival times = [ exponential, 0.0, 10.0 ],  

  Sequential inter-arrival times = [ exponential, 0.0, 10.0 ],  

  Local inter-arrival times = [ exponential, 0.0, 10.0 ],  

  Local distances = [ normal, 0.0, 40000.0 ],  

  Sizes = [ exponential, 0.0, 8.0 ]  

} # end of generator 0
```

PS. In this part, we particularly use 5 disks to do the simulation.

B. Result

disk number	5	6	7	8
storage per disk	8224032	10280040	12336048	14392056
average response time	24.259399	22.832740	21.411985	20.848690

TABLE I

DISK NUMBER VS AVERAGE RESPONSE TIME(PART ONE).

disk number	9	10	11
storage per disk	16448064	18504072	20560080
average response time	20.302940	19.814423	19.527606

TABLE II

DISK NUMBER VS AVERAGE RESPONSE TIME(PART TWO).

IV. PARAID5

A. Parameter initialize

There are gears: one with 4 disks (gear 1) and the other with 5 disks (gear 2). Each gear has its own parameter file. The parameter file of the one with 5 disks is the same with that of the 5-disk RAID-5.

We made the following change in that of 4-disk one.

- 1) [ctrl0 .. ctrl4] \longrightarrow [ctrl0 .. ctrl3]
- 2) [disk0 .. disk4] \longrightarrow [disk0 .. disk3]
- 3) Storage capacity per device = 8224032 \longrightarrow Storage capacity per device = 6168024

B. Implementation

We call the parameter file of gear 1 "paraid5_1.parv" and out file "paraid5_1.outv". We call the parameter file of gear 2 "paraid5_2.parv" and out file "paraid5_2.outv". We write a python code to transfer from one gear to the other. To run command line in python, we use the os package.

For example,

```
1 import os  

2 os.system("ls -l")
```

will show the detailed file information in the current route, which just like call "ls -l" in the terminal.

By running

```
1 os.system("../src/disksim paraid5_1.parv paraid5_1.outv  

  ascii 0 1")
```

we get paraid5_1.outv. After the script opening and reading paraid5_1.outv, it will know the U and S where U denotes the average utilization time and S denotes the stand deviation of utilization time.

What we do in gear 2 is similar.

When in gear 1, if $U + S > T$, up shift. When in gear 2, if $U + S < T$, down shift.

C. Result

In our test,the result is the following.

gear	average response time	U	S	U+S
1	27.285464	0.53083	0.36681722109	0.89764722109
2	24.303764	0.54973	0.026532336035	0.576262336035

TABLE III
U AND S FOR EACH GEAR

D. Theory Analysis

Gearing is a process of driving a car. If we want to change the driving mode, we need gear. Gearing of the PARAID is similar to gearing of the car.

There are three modes of disks: idle, standby and active. Certainly,the active mode consumes more energy than other modes. However, switching mode also consumes lots of energy. To save energy, we need keep balance among the modes.

An idea is that we let fewer disks respond to the I/O instructions when the total workload is not heavy and let more disks respond to the I/O instructions when the total workload is heavy. Hence the workload is asymmetric. PARAID works in this way.

E. Difficulties

It's very difficult and we just made a naive version. What we can do is reading the DiskSim Manual[1] and "PARAID" paper[2]. Perhaps we need more guidance from teacher and TAs.

V. Power Management Module

A. Design details of the module

B. Results

C. Difficulties

It's too difficult that we even wasted many days reading everything can be searched about this mission but get little help. And after asking some people, we simply made a naive version and we found it difficult to understand all the theory behind it. Actually we hope to read some recommended papers from teacher and TAs.

REFERENCES

- [1] DiskSim Version 4.0 Reference Manual: <http://www.pdl.cmu.edu/PDL-FTP/DriveChar/CMU-PDL-08-101.pdf>
- [2] Weddle, Charles, et al. "PARAID: The gearshifting power-aware RAID." *Acm Transactions on Storage* 3.3(2007):13.