

README FILE

GEM5 EXECUTION STEPS

Files Found

Linearcomplete.c
Linearoverhead.c
Linear.sh
Randcomplete.c
Randoverhead.c
Random.sh
stat.txt

Understanding the Files

In order to do the cache access time measurements, we have 2 files – xxxcomplete.c files which are the complete code. Xxxoverhead.c files are files that measure only overheads in measuring average access times. Thus, average access ticks are calculated as follows

$$\text{Access_Time_Ticks} = (\text{Ticks_complete} - \text{Ticks_overheads}) / \text{Array_Size}$$

The xxxx.sh scripts are using to compile various C codes and run the gem5 syscall simulator for multiple array sizes.

Steps to Execute

1. After having unzipped the Assignment zip file, we need to update the paths in all the shell scripts. The instructions are as follows for Gem5 scripts

- I. Update the path to C code in the Gcc command on line 2 and 24.

```
gcc -o Linearcomplete -Wall ~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assign01/Gem5/Linearcomplete.c
```

- II. Update the simulator and source code path to the GEM5 simulator command.

```
~/gem5/build/X86/gem5.opt --outdir=~/gem5/tests ~/gem5/configs/example/se.py --cpu-clock=1GHz  
--cpu-type=DerivO3CPU --caches --l1i_size=32kB --l1i_assoc=2 --l1d_size=64kB --l1d_assoc=4  
--l2cache --l2_size=256kB --l2_assoc=16 -c ~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assign01/Gem5/Linearcomplete --options=1
```

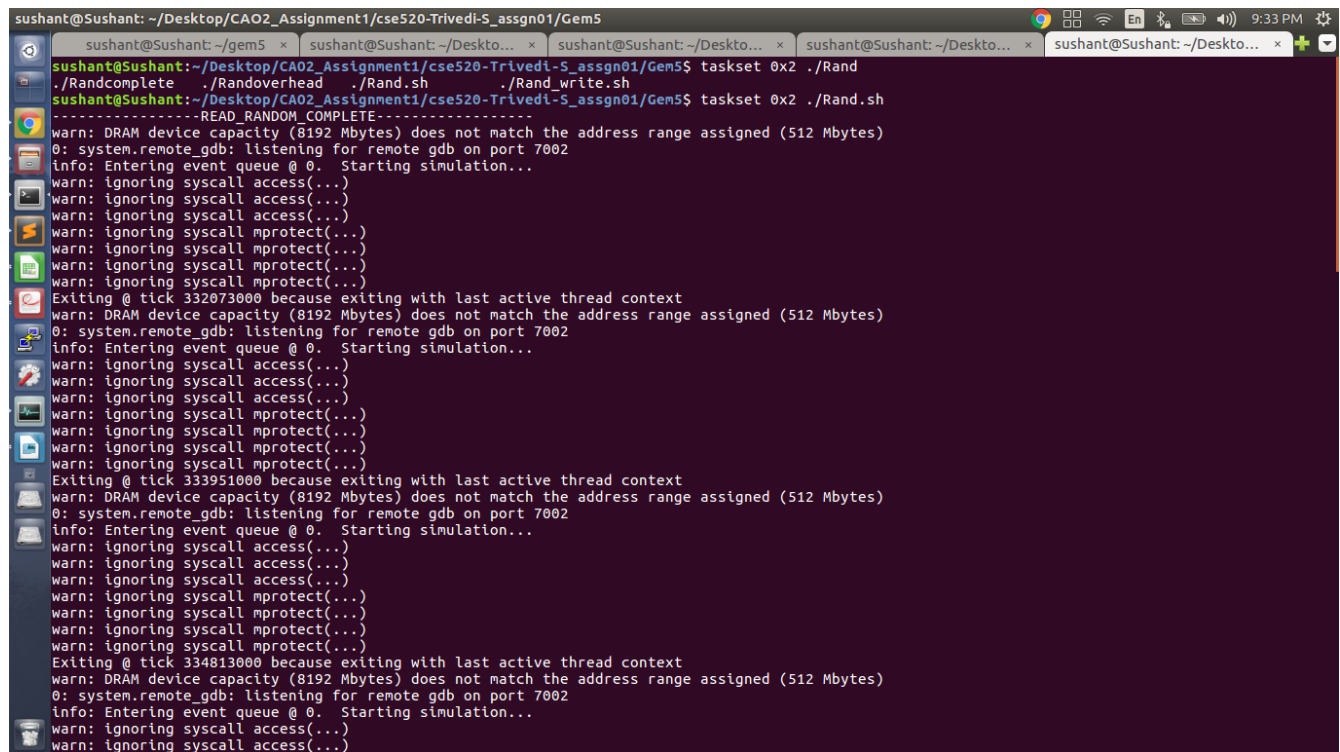
In the above command update the highlighted parts with the correct path. This would be required to be done in all the Gem5 commands, we have multiple commands for various array sizes.

2. Having updated the scripts with correct paths to simulator and source code. Use the following command to call the script from the directory it is in. We need to use the taskset command to make sure it runs on one specific Core.

Assuming we are already in /cse520-Trivedi-S_assign01/Gem5/ directory, run

```
taskset 0x1 ./Random.sh  
or  
taskset 0x1 ./Linear.sh
```

These script would measure the read access times for Random and Linear Access times.



```
sushant@sushant: ~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assgn01/Gem5
sushant@sushant: ~/gem5 x sushant@sushant: ~/Desko... x sushant@sushant: ~/Desko... x sushant@sushant: ~/Desko... x sushant@sushant: ~/Desko... x
sushant@sushant:~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assgn01/Gem5$ taskset 0x2 ./Rand
./Randcomplete ./Randoverhead ./Rand.sh ./Rand_write.sh
sushant@sushant:~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assgn01/Gem5$ taskset 0x2 ./Rand.sh
-----READ_RANDOM_COMPLETE-----
warn: DRAM device capacity (8192 Mbytes) does not match the address range assigned (512 Mbytes)
0: system.remote_gdb: listening for remote gdb on port 7002
info: Entering event queue @ 0. Starting simulation...
warn: ignoring syscall access(...)
warn: ignoring syscall access(...)
warn: ignoring syscall access(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
Exiting @ tick 332073000 because exiting with last active thread context
warn: DRAM device capacity (8192 Mbytes) does not match the address range assigned (512 Mbytes)
0: system.remote_gdb: listening for remote gdb on port 7002
info: Entering event queue @ 0. Starting simulation...
warn: ignoring syscall access(...)
warn: ignoring syscall access(...)
warn: ignoring syscall access(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
Exiting @ tick 333951000 because exiting with last active thread context
warn: DRAM device capacity (8192 Mbytes) does not match the address range assigned (512 Mbytes)
0: system.remote_gdb: listening for remote gdb on port 7002
info: Entering event queue @ 0. Starting simulation...
warn: ignoring syscall access(...)
warn: ignoring syscall access(...)
warn: ignoring syscall access(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
Exiting @ tick 334813000 because exiting with last active thread context
warn: DRAM device capacity (8192 Mbytes) does not match the address range assigned (512 Mbytes)
0: system.remote_gdb: listening for remote gdb on port 7002
info: Entering event queue @ 0. Starting simulation...
warn: ignoring syscall access(...)
warn: ignoring syscall access(...)
```

Sample Execution of the file.

GEM5 CONFIGURATION AS PER ASSIGNMENT

The assignment required us to configure GEM5 with the following settings.

CLOCK EXECUTION STEPS

Files Found

- Linear.sh → contains script to execute the measurements for linear access read and writes
- Random.sh → contains script to execute the measurements for random access read and write
- Clock_linear.c → C code for Linear Access
- Clock_random.c → C code for Random Access

Understanding the Files

The shell compiles the GCC code to generate the executable and runs it by passing it parameters as follows:

./executable Array_Size (1 – Read or 2 – Write)
eg: ./Clock_linear 65536 1

Linear Access:

We have simulated the linear access using multiple strides to assess the memory mountain.
Please modify stride variable on line 87 of Clock_linear.c

Steps to Execute

1. In order to run, you need to unzip the folder and navigate to Clock folder within the zip.
2. Once within Clock directory, execute Linear.sh or Random.sh to get results.

taskset 0x1 ./Linear.sh

taskset 0x1 ./Random.sh

3. This would print output in the following format. First the read measurements followed by write measurements.

Array Size Time(ns)

eg output:

RANDOM_READ

1 3.000000 ns

2 2.500000 ns

..

..

..

RANDOM_WRITE

1 3.000000 ns

2 2.500000 ns

```
sushant@Sushant: ~/gem5 * sushant@Sushant: ~/Desktop/CAO2_Assignment1/cs... * sushant@Sushant: ~/Desktop/CAO2_Assignment1/cs... *
repeat=100;
Clock_random.c:27:2: note: each undeclared identifier is reported only once for each function it appears in
sushant@Sushant:~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assign01/Clock$ gcc -o Clock_random -Wall Clock_random.c
sushant@Sushant:~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assign01/Clock$ taskset 0x1 ./Random.sh
RANDOM_READ
1 3.333333 ns
2 2.666667 ns
4 2.416667 ns
8 2.666667 ns
16 3.062500 ns
32 3.843750 ns
64 4.177083 ns
128 3.880208 ns
256 3.753906 ns
512 4.193359 ns
1024 6.102865 ns
2048 6.583743 ns
4096 9.481204 ns
8192 11.814087 ns
16384 14.736938 ns
32768 27.109985 ns
65536 52.435760 ns
131072 73.599854 ns
262144 81.078415 ns
524288 86.127834 ns
1048576 89.715939 ns
2097152 95.661526 ns
4194304 102.178266 ns
8388608 110.182582 ns
16777216 132.046435 ns
RANDOM_WRITE
1 0.000000 ns
2 0.000000 ns
4 0.000000 ns
8 0.000000 ns
16 0.000000 ns
32 0.000000 ns
64 0.000000 ns
128 0.000000 ns
256 0.000000 ns
```

PERF EXECUTION STEPS

Files Found

PerfLin.sh

PerLin_complete.c

PerfLin_overhead.c

PerfRand.sh

PerRand_Complete.c

PerfRand_overhead.c

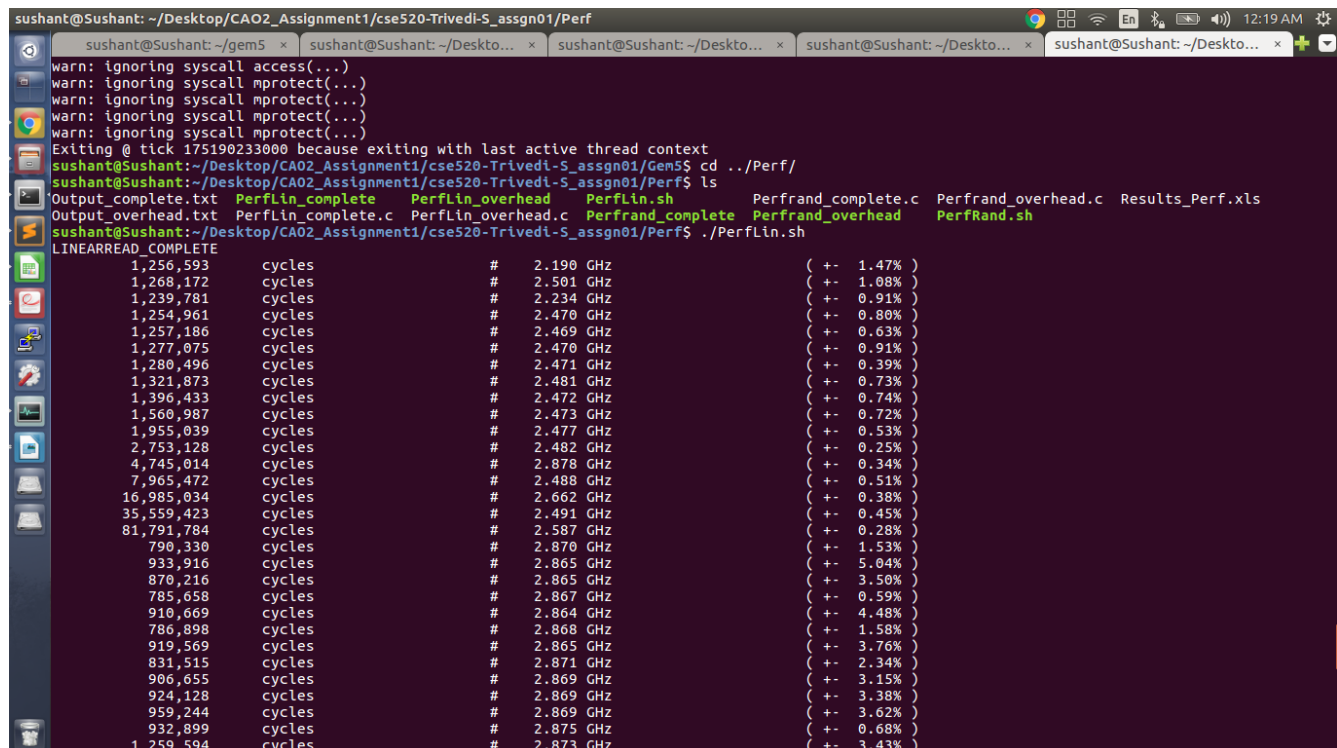
Understanding the File

The script executed the read complete, then read overhead, write_complete and write_overhead measurements. It just needs to be executed. The second parameter passes to files in argv param is whether it is read → 1 or write → 2. First parameter is the array size

Steps to Execute

1. Update the paths as explained earlier for the different shell files and then execute the shell files. They would output as follows

Execute each script on a specific CPU using taskset
taskset 0x1 ./Script_name



```
sushant@Sushant: ~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assgn01/Perf
sushant@Sushant: ~/gem5 x sushant@Sushant: ~/Desko... x sushant@Sushant: ~/Desko... x sushant@Sushant: ~/Desko... x sushant@Sushant: ~/Desko... x
warn: ignoring syscall access(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
warn: ignoring syscall mprotect(...)
Exiting @ tick 175190233000 because exiting with last active thread context
sushant@Sushant: ~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assgn01/Gem5$ cd ../Perf/
sushant@Sushant: ~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assgn01/Perf$ ls
Output_complete.txt  PerfLin_complete  PerfLin_overhead.c  PerfLin.sh  PerfRand_complete.c  PerfRand_overhead.c  Results_Perf.xls
Output_overhead.txt  PerfLin_complete.c  PerfLin_overhead.c  PerfRand_complete  PerfRand_overhead  PerfRand.sh
sushant@Sushant: ~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assgn01/Perf$ ./PerfLin.sh
LINEARREAD_COMPLETE
1,256,593 cycles # 2.190 GHz ( +- 1.47% )
1,268,172 cycles # 2.501 GHz ( +- 1.08% )
1,239,781 cycles # 2.234 GHz ( +- 0.91% )
1,254,961 cycles # 2.470 GHz ( +- 0.80% )
1,257,186 cycles # 2.469 GHz ( +- 0.63% )
1,277,075 cycles # 2.470 GHz ( +- 0.91% )
1,280,496 cycles # 2.471 GHz ( +- 0.39% )
1,321,873 cycles # 2.481 GHz ( +- 0.73% )
1,396,433 cycles # 2.472 GHz ( +- 0.74% )
1,560,987 cycles # 2.473 GHz ( +- 0.72% )
1,955,039 cycles # 2.477 GHz ( +- 0.53% )
2,753,128 cycles # 2.482 GHz ( +- 0.25% )
4,745,014 cycles # 2.878 GHz ( +- 0.34% )
7,965,472 cycles # 2.488 GHz ( +- 0.51% )
16,985,034 cycles # 2.662 GHz ( +- 0.38% )
35,559,423 cycles # 2.491 GHz ( +- 0.45% )
81,791,784 cycles # 2.587 GHz ( +- 0.28% )
790,330 cycles # 2.870 GHz ( +- 1.53% )
933,916 cycles # 2.865 GHz ( +- 5.04% )
870,216 cycles # 2.865 GHz ( +- 3.50% )
785,658 cycles # 2.867 GHz ( +- 0.59% )
910,669 cycles # 2.864 GHz ( +- 4.48% )
786,898 cycles # 2.868 GHz ( +- 1.58% )
919,569 cycles # 2.865 GHz ( +- 3.76% )
831,515 cycles # 2.871 GHz ( +- 2.34% )
906,655 cycles # 2.869 GHz ( +- 3.15% )
924,128 cycles # 2.869 GHz ( +- 3.38% )
959,244 cycles # 2.869 GHz ( +- 3.62% )
932,899 cycles # 2.875 GHz ( +- 0.68% )
1,259,594 cycles # 2.873 GHz ( +- 3.43% )
```

NOTE: Sometimes the scripts may give certain permission denied error. Then do the following
chmod +x ./script_name

GEM5 simulator configuration

CPU type:

L1 instruction cache:

L1 data cache:

L2 unified cache:

DerivO3CPU

2-way set-associate, total size 32KB, LRU

4-way set-associate, total size 64KB, LRU

16-way set-associate, total size 256KB, LRU

cacheline_size=64 bytes.

CPU in the simulator running in 1000MHz

These have been done in the script file by means of various flags as shown below

```
~/gem5/build/X86/gem5.opt --outdir=~/.gem5/tests ~/gem5/configs/example/se.py --cpu-  
clock=1GHz --cpu-type=DerivO3CPU --caches --l1i_size=32kB --l1i_assoc=2 --l1d_size=64kB  
--l1d_assoc=4 --l2cache --l2_size=256kB --l2_assoc=16 -c  
~/Desktop/CAO2_Assignment1/cse520-Trivedi-S_assgn01/Gem5/Linearcomplete --options=1  
1
```