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Lab 1 Report

Equations:

CPI$_{calculated}$ = 1 + (No. of One Cycle Stalls + 2*No. of Two Cycle Stalls)/Total Number of Instructions

Slowdown = (CPI$_{calculated}$ - 1)/1

For Question 1:

CPI$_{calculated}$ = 1 + 1/13 + 2*4/13 = **1.6923**
% drop $_{calculated}$ (slowdown) = **69.23%**
CPI$_{mbq1}$ = **1.9129**
% drop $_{calculated}$ (slowdown) = **91.29%**
CPI $_{EIO}$ = **1.6669**
% drop $_{EIO}$(slowdown) = **66.69%**

For Question 2:

CPI$_{calculated}$ = 1 + 1/13 + 2*2/13 = **1.3846**
% drop $_{calculated}$ (slowdown) = **38.46%**
CPI$_{mbq1}$= **1.4347**
% drop $_{calculated}$ (slowdown) = **43.47%**
CPI $_{EIO}$ = **1.3975**
% drop $_{EIO}$(slowdown) = **39.75%**

The reason for the large discrepency between our CPI calculated vs CPI mbq1 is due to the fact hazards are introduced in the for loop and initialization. However, we ran a version of our benchmark that only contained the for loop and initialization hazards(*Figure 3*) , and thus we were able to see our actual hazard counts due to our benchmark.

We used the -O0 compiler flag and iterated the loop 1,000,000 times to achieve steady state results

Our microbenchmark contains 4 two cycle stalls and 1 one cycle stall for question 1, and 2 one cycle stalls and 1 two cycle stall for question 2. As such, we expect the ratio of one cycle stalls and two cycle stalls to be reflected in the count produced by sim-safe. The following are screenshots showing the correctness of our logic. *Figure 3* shows the number of hazards with just a pure for loop. If we subtract this value from the values we obtained with the microbenchmark code (*Figure 4*), we see that the ratios are correct.

Question 1: One cycle stall:Two cycle stall = (1000091-91):(10000854-6000854) = **1:4**
Question 2: One cycle stall:Two cycle stall = (6000778-4000778):(2000091-1000091) = **2:1**

Q2

Instruction	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	c13	c14	c15	c16	c17	c18	c19	c20	c21	c22	c23	c24	c25	c26	c27	c28	c29
addi $4, $0, 1	F	D	X1	X2	M	W																							
addi $5, $0, 1		F	D	X1	X2	M	W																						
add $3, $4, $0			F	D	X1	X2	M	W																					
add $5, $4, $3				F	D	d*	X1	X2	M	W	// 1 cycle q2																		
add $6, $4, $3					F	p*	D	X1	X2	M	W																		
addi $6, $0, 1							F	D	X1	X2	M	W																	
add $4, $6, $0								F	D	d*	X1	X2	M	W	// 1 cycle q2														
addi $6, $0, 1									F	p*	D	X1	X2	M	W														
lw $7, 0($3)											F	D	X1	X2	M	W													
sub $5, $7, $3												F	D	d*	d*	X1	X2	M	W	// 2 cycle q2									
lw $7, 0($3)													F	p*	p*	D	X1	X2	M	W									
sw $7, 0($1)																F	D	X1	X2	M	W	// 0 stall q2 because of bypassing							
add $6, $0, 6																	F	D	X1	X2	M	W							

Figure 1*: mbq1 pipeline diagram for Q1*

Q1

Instruction	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	c13	c14	c15	c16	c17	c18	c19	c20	c21	c22	c23	c24	c25	c26	c27	c28	c29
addi $4, $0, 1	F	D	X	M	W																								
addi $5, $0, 1		F	D	X	M	W																							
add $3, $4, $0			F	d*	D	X	M	W	// 1 cycle q1																				
add $5, $4, $3				p*	F	d*	d*	D	X	M	W	// 2 cycle q1																	
add $6, $4, $3						p*	p*	F	D	X	M	W	// no q1 stall because eaten up by previous instr																
addi $6, $0, 1									F	D	X	M	W																
add $4, $6, $0										F	d*	d*	D	X	M	W	// 2 cycle q1												
addi $6, $0, 1											p*	p*	F	D	X	M	W												
lw $7, 0($3)														F	D	X	M	W											
sub $5, $7, $3															F	d*	d*	D	X	M	W	// 2 cycle q1							
lw $7, 0($3)																p*	p*	F	D	X	M	W							
sw $7, 0($1)																			F	d*	d*	D	X	M	W	// 2 cycle q1			
add $6, $0, 6																				p*	p*	F	D	X	M	W			

Figure 2*: mbq1 pipeline diagram for Q2*

```
sim: ** simulation statistics **
sim_num_insn               11006312 # total number of instructions executed
sim_num_refs                3003722 # total number of loads and stores executed
sim_elapsed_time                  1 # total simulation time in seconds
sim_inst_rate         11006312.0000 # simulation speed (in insts/sec)
sim_num_loads               2000353 # total number of load instructions
sim_load_ratio               0.1817 # load instruction fraction
sim_num_lduh                1000091 # total number of load use hazards
sim_load_use_ratio           0.0909 # load use fraction
sim_num_RAW_hazard_q1       6000945 # total number of RAW hazards (q1)
sim_num_RAW_hazard_q2       5000869 # total number of RAW hazards (q2)
sim_num_one_cycle_hazard_q1      91 # total number of one cycle stalls (q1)
sim_num_two_cycle_hazard_q1 6000854 # total number of two cycle stalls (q1)
sim_num_one_cycle_hazard_q2 4000778 # total number of one cycle stalls (q2)
sim_num_two_cycle_hazard_q2 1000091 # total number of two cycle stalls (q2)
CPI_from_RAW_hazard_q1       2.0904 # CPI from RAW hazard (q1)
CPI_from_RAW_hazard_q2       1.5452 # CPI from RAW hazard (q2)
ld_text_base             0x00400000 # program text (code) segment base
ld_text_size                  23200 # program text (code) size in bytes
ld_data_base             0x10000000 # program initialized data segment base
ld_data_size                   4096 # program init'ed `.data' and uninit'ed `.bss' size in bytes
ld_stack_base            0x7fffc000 # program stack segment base (highest address in stack)
ld_stack_size                 16384 # program initial stack size
ld_prog_entry            0x00400140 # program entry point (initial PC)
ld_environ_base          0x7fff8000 # program environment base address address
ld_target_big_endian              0 # target executable endian-ness, non-zero if big endian
mem.page_count                   13 # total number of pages allocated
mem.page_mem                    52k # total size of memory pages allocated
mem.ptab_misses                  13 # total first level page table misses
mem.ptab_accesses          50175958 # total page table accesses
mem.ptab_miss_rate           0.0000 # first level page table miss rate

ug173:~/ece552/lab1/simplesim-3.0d-ece552f-assign1%
```

Figure 3*: modified benchmark simulation results*

```
sim: ** simulation statistics **
sim_num_insn               23006312 # total number of instructions executed
sim_num_refs                6003722 # total number of loads and stores executed
sim_elapsed_time                  1 # total simulation time in seconds
sim_inst_rate         23006312.0000 # simulation speed (in insts/sec)
sim_num_loads               4000353 # total number of load instructions
sim_load_ratio               0.1739 # load instruction fraction
sim_num_lduh                2000091 # total number of load use hazards
sim_load_use_ratio           0.0869 # load use fraction
sim_num_RAW_hazard_q1      11000945 # total number of RAW hazards (q1)
sim_num_RAW_hazard_q2       8000869 # total number of RAW hazards (q2)
sim_num_one_cycle_hazard_q1      1000091 # total number of one cycle stalls (q1)
sim_num_two_cycle_hazard_q1     10000854 # total number of two cycle stalls (q1)
sim_num_one_cycle_hazard_q2      6000778 # total number of one cycle stalls (q2)
sim_num_two_cycle_hazard_q2      2000091 # total number of two cycle stalls (q2)
CPI_from_RAW_hazard_q1       1.9129 # CPI from RAW hazard (q1)
CPI_from_RAW_hazard_q2       1.4347 # CPI from RAW hazard (q2)
ld_text_base             0x00400000 # program text (code) segment base
ld_text_size                  23296 # program text (code) size in bytes
ld_data_base             0x10000000 # program initialized data segment base
ld_data_size                   4096 # program init'ed `.data' and uninit'ed `.bss' size in bytes
ld_stack_base            0x7fffc000 # program stack segment base (highest address in stack)
ld_stack_size                 16384 # program initial stack size
ld_prog_entry            0x00400140 # program entry point (initial PC)
ld_environ_base          0x7fff8000 # program environment base address address
ld_target_big_endian              0 # target executable endian-ness, non-zero if big endian
mem.page_count                   14 # total number of pages allocated
mem.page_mem                    56k # total size of memory pages allocated
mem.ptab_misses                  17 # total first level page table misses
mem.ptab_accesses         104176532 # total page table accesses
mem.ptab_miss_rate           0.0000 # first level page table miss rate

ug173:~/ece552/lab1/simplesim-3.0d-ece552f-assign1%
```

***Figure 4**: benchmark simulation results*

```
sim: ** simulation statistics **
sim_num_insn              279373007 # total number of instructions executed
sim_num_refs              109106589 # total number of loads and stores executed
sim_elapsed_time                 12 # total simulation time in seconds
sim_inst_rate         23281083.9167 # simulation speed (in insts/sec)
sim_num_loads              71001838 # total number of load instructions
sim_load_ratio               0.2541 # load instruction fraction
sim_num_lduh               20126394 # total number of load use hazards
sim_load_use_ratio           0.0720 # load use fraction
sim_num_RAW_hazard_q1      98137951 # total number of RAW hazards (q1)
sim_num_RAW_hazard_q2      90933806 # total number of RAW hazards (q2)
sim_num_one_cycle_hazard_q1      9955637 # total number of one cycle stalls (q1)
sim_num_two_cycle_hazard_q1     88182314 # total number of two cycle stalls (q1)
sim_num_one_cycle_hazard_q2     70807412 # total number of one cycle stalls (q2)
sim_num_two_cycle_hazard_q2     20126394 # total number of two cycle stalls (q2)
CPI_from_RAW_hazard_q1       1.6669 # CPI from RAW hazard (q1)
CPI_from_RAW_hazard_q2       1.3975 # CPI from RAW hazard (q2)
ld_text_base             0x00400000 # program text (code) segment base
ld_text_size                2166768 # program text (code) size in bytes
ld_data_base             0x10000000 # program initialized data segment base
ld_data_size                 264644 # program init'ed `.data' and uninit'ed `.bss' size in bytes
ld_stack_base            0x7fffc000 # program stack segment base (highest address in stack)
ld_stack_size                 16384 # program initial stack size
ld_prog_entry            0x00400140 # program entry point (initial PC)
ld_environ_base          0x7fff8000 # program environment base address address
ld_target_big_endian              0 # target executable endian-ness, non-zero if big endian
mem.page_count                  875 # total number of pages allocated
mem.page_mem                  3500k # total size of memory pages allocated
mem.ptab_misses                 894 # total first level page table misses
mem.ptab_accesses        1341120003 # total page table accesses
mem.ptab_miss_rate           0.0000 # first level page table miss rate

ug173:~/ece552/lab1/simplesim-3.0d-ece552f-assign1%
```

***Figure 5**: EIO trace simulation results*