Hw 2
Anooj Pai

3.15.5)

A) P1 = 3 / 1.5 = 2 * 10^9, P2 = 2.5 / 1 = 2.5 * 10^9, P3 = 4 / 2.2 = 1.8 *10^9

Answer = P2 at 2.5 * 10^9 instructions per second

B)

Processor	Cycles
P1	3 * 10 = 3 * 10^10
P2	2.5 * 10 = 2.5 * 10^10
P3	4 * 10 = 4 * 10^10

Processor	Instructions
P1	3 * 10 / 1.5 = 2 * 10^10
P2	2.5 * 10 / 1 = 2.5 * 10^10
P3	4 * 10 / 2.2 = 1.8 * 10^10

C) Clock rate * 1.2 / 0.7 = 1.71 * Clock rate

Processor	New Clock Rate
P1	3 * 1.71 = 5.13 GHz
P2	2.5 * 1.71 = 4.27 GHz
P3	4* 1.71 = 6.84 GHz

3.15.7)

A)

P1 time = (10^5+2*10^5*2+5*10^5*3+2*10^5*3)/(2.5*10^9) = 10.4*10^-4 seconds
P2 time = (10^5*2+2*10^5*2+5*10^5*2+2*10^5*2)/(3*10^9) = 6.66*10^-4 seconds

Global CPI P1 = 10.4*10^-4*2.5*10^9/10^6 = Global CPI P1 = 2.6
Global CPI P2 = 6.66*10^-4*3*10^9/10^6   = Global CPI P2 = 2.0

B) Class A: 10^5
Class B: 2 * 10^5
Class C: 5 * 10^5
Class D: 2 * 10^5

P1 = 10^5 * 1 + 2 * 10^5 * 2 + 5 * 10^5 * 3 + 2 * 10^5 * 3 = 26 * 10^5
P2 = 10^5 * 2 + 2 * 10^5 * 2 + 5 * 10^5 * 2 + 2 * 10^5 * 2 = 20 * 10^5

3.15.8)

A) Compiler A = 1.1 / (1.0E9 × 1.0E-9) = 1.1
Compiler B = 1.5 / (1.2E9 × 1.0E-9) = 1.25

B) (Instructions1 * CPI1) / Clock Rate1 = (Instructions2 * CPI2) / Clock Rate2

Clock Rate1 = (Instructions1 * CPI1) / (Instructions2 * CPI2) * Clock Rate2

Clock Rate1 = (10^9 * 1.1) / (1.2 * 10^9 * 1.25) * Clock Rate 2

Clock Rate1 = (0.73)Clock Rate2 so ClockRate1 is 27% slower than CR2

C) CPU Time C = 6 * 10^8 * 1.1 * 10^-9 = 0.66 seconds

C Compared to A = 1.1 / 0.66 = 1.67

C Compared to B = 1.5 / 0.66 = 2.27

A is 1.67 times slower than C and B is 2.27 slower

3.15.10)

A) Clock Cycles = Instruction Count * Cycles per Instruction

1 Processor:

Clock Cycles = ((2.56 * 10^9 * 1) + (1.28 * 10^9 * 12) + (256 * 10^6 * 5)) = 1.92 * 10^10

Clock Speed = 2 * 10^9

(1.92 * 10^10) / (2 * 10^9) = 9.6 sec

1 Processor = 9.6 seconds

Clock cycles = (2.56 * 10^9 * 1) / 0.7p + (1.28 * 10^9 * 12) / 0.7p + 256 * 10^6 * 5

Execution time = (2.56 * 10^9 * 1) / 0.7p + (1.28 * 10^9 * 12) / 0.7p + 256 * 10^6 * 5 / 2 * 10^9 Hz = 12.8 / p + 0.64

2 Processors:

Execution time = 12.8 / 2 + 0.64 = 7.04

Relative Speedup = 9.6 / 7.04 = 1.36

Execution time = 7.04 seconds

Relative Speed up = 1.36

4 Processors:

Execution time = 12.8 / 4 + 0.64 = 3.84

Relative Speedup = 9.6 / 3.84 = 2.5

Execution time = 3.84 seconds

Relative Speed = 2.5

When p = 8 (p is # of processors):

Execution time = 12.8 / 8 + 0.64 = 2.24
Relative Speedup = 9.6 / 2.24 = 4.29

Execution time = 2.24 seconds
Relative Speed up = 4.29

B)
1 Processor CPI Doubled:
Clock Cycle = 2560*2 + 1280*12 + 256*5 = 21760
CPU Execution Time = (21760)/ (2 * 10^9) = 4.297

1 Processor CPI Doubled = 10.88ms

2 Processors CPI Doubled:
Clock Cycle = ((2560/(0.7*2))*2) + ((1280/(0.7*2))*12) + 256*5 = 15908.57
CPU Execution Time = (15908.57)/ (2 * 10^9) = 4.297

2 Processors CPI Doubled = 7.954ms

4 Processors CPI Doubled:
Clock Cycle = ((2560/(0.7*4))*2) + ((1280/(0.7*4))*12) + 256*5 = 8594.28
CPU Execution Time = (8594.28)/ (2 * 10^9) = 4.297

4 Processors CPI Doubled = 4.297ms

8 Processors CPI Doubled:
Clock Cycle = ((2560/(0.7*8))*2) + ((1280/(0.7*8))*12) + 256*5 = 4937.08
CPU Execution Time = (4937.08)/ (2 * 10^9) = 2.468

8 Processors CPI Doubled = 2.468ms

C)
Execution Time With 4 Processors: 3.84 seconds

CPU execution time = ((3.84*10^9 + 1.28*10^9 * a) / (2*10^9))
= ((3.84*10^9) / (2*10^9)) + (1.28*10^9 * a/(2*10^9))
3.84 = 1.92 + 0.64*a
a = 3

Reduced CPI = 3/12 = 0.25

The CPI of load/store instructions needs to be reduced by 25%

3.15.12)

A)

CPI = (750)/(2.389E12 * 0.33*10^-9) = 0.9425

CPI = 0.94

B)

SPEC Ratio = 9650/750 = 12.866

SPEC Ratio = 12.87

C)

CPU Time increased by 10% = 1.1 * 750 = 825

825-750/750 = 0.1 = 10%

With an increase of 10%, the new CPU Time would be 825s

D)

CPU Time = (1.1*1.05)*Instruction Count * CPI * Clock Cycle Time =1.155 * Old CPU Time =1.155 * 750 = 866.25

866.25-750/750 = 116.25/750 = 0.155 = 15.5%

With an increase of 10% of instructions and 5% on CPI, the new CPI Time would be 866.25sec and a 15.5% increase

E)

Reference Time = 9650, New Execution Time = 866.25
9650/866.25 = 11.14s

Change in SPEC ratio = (11.14 - 12.87)/12.87 = 13.44

Change in SPEC ratio is 13.44%

F)

New instruction count after reduced by 15% = 2.03*10^12
700 = (CPI * 2.03 * 10^12)/(4*10^9)
CPI = 1.37
New CPI = 1.37 cycles

G)
Change in CPI = (1.37-0.94)/0.94 = 0.43
Clock Rate Change = (4.0*10^9 - 3.0*10^9)/3.0*10^9 = 0.333
The instruction rate has decreased.

The increase in the CPI is almost the same as the clock rate

H)
Start CPU time = 750, final CPU time after decrease = 700
CPU Time = (750-700/700) * 100 = 6.66%

The CPU Time was reduced by 6.66%

I)
New Execution Time = 960- (960*10/100) = 960-96 = 864
Number of Instructions = (960*0.9*10^-9*4*10^9)/1.61 = 2147

If the execution time is reduced by 10% with a clock rate of 4 GHz the Number of Instructions is 2147

J)
Final execution time = 864, CPI = 1.61, Clock Rate = 4GHz

New Changed Clock Rate = (1.61*2147)/(864*0.9*10^-9)
New Clock Rate = 4.45 GHz

The Clock Rate needed to reduce 10 of CPU time is 4.45GHz

K)
Reduced CPU time = (90-0.2*960) = 768 * 0.8 = 622.08

Reduced CPI = 1.61-0.15*1.62 = 1.367

Clock Rate = (2147* 1.367)/(622.08 * 10^-9) = 4.723 GHz

With the CPI reduced by 15% and the CPU Time reduced by 20% the new Clock Rate is 4.723 GHz

3.15.15)

instructions = (50 * 10^6) + (110 * 10^6) + (80 * 10^6) + (16 * 10^6) = 256 * 10^6

A) CPIAVG = ((50 * 10^6)/ (256 * 10^6)) + ((110 * 10^6)/ (256 * 10^6)) + (4 * (80 * 10^6)/ (256 * 10^6)) + (2 * ((16 * 10^6)/ (256 * 10^6)) = 2

CPIFAST = ((50 * 10^6) * X/ (256 * 10^6)) + ((110 * 10^6)/ (256 * 10^6)) + (X * (80 * 10^6) * 4/ (256 * 10^6)) + (2 * ((16 * 10^6)/ (256 * 10^6)) = 1

X = -4.12 meaning it is not possible for the program to run faster by improving the CPI of FP instructions

B) CPIAVG = ((50 * 10^6)/ (256 * 10^6)) + ((110 * 10^6)/ (256 * 10^6)) + (4 * (80 * 10^6)/ (256 * 10^6)) + (2 * ((16 * 10^6)/ (256 * 10^6)) = 2

CPIFAST = ((50 * 10^6)/ (256 * 10^6)) + ((110 * 10^6)/ (256 * 10^6)) + (X * (80 * 10^6)/ (256 * 10^6)) + (2 * ((16 * 10^6)/ (256 * 10^6)) = 1

X = 0.8 meaning we need to reduce the instructions by 80%

C) CPIAVG = (0.6 * (50 * 10^6)/ (256 * 10^6)) + (0.6 * (110 * 10^6)/ (256 * 10^6)) + ((0.6 *4) * (80 * 10^6)/ (256 * 10^6)) + ((0.6 * 2) * ((16 * 10^6)/ (256 * 10^6)) = 1.34

1 – CPIFAST/CPIAVG = 1 – 1.34/2 = 0.33 = 33%