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1.9, 1.11

1.91: single processor: CPU Time1 = Count × CPI × Cycle Time

$= \frac{2.56\times10^9}{} \times 1 \times \frac{1}{2\times10^9} = 1.28s$

CPU Time2 = Count × CPI × Cycle Time

$= \frac{1.28\times10^9}{} \times 12 \times \frac{1}{2\times10^9} = 7.68s$

CPU Time3 $= 2.56\times10^8 \times 5 \times \frac{1}{2\times10^9} = 0.64s$

$\therefore T = 1.28 + 7.68 + 0.64 = 9.6s$

Two processors: $T = \sum_{i=1}^{3}$ CPU Time$_i$ $= \Sigma$ (Count × CPI × Cycle Time)

$= \frac{2.56\times10^9}{0.7\times2} \times 1 \times \frac{1}{2\times10^9} + \frac{1.28\times10^9}{0.7\times2} \times 12 \times \frac{1}{2\times10^9} + 2.56\times10^8 \times 5 \times \frac{1}{2\times10^9}$

$= 7.04s$

Four processors: $T = \Sigma$ (Count × CPI × Cycle Time)

$= \frac{2.56\times10^9}{0.7\times4} \times \frac{1}{2\times10^9} + \frac{1.28\times10^9}{0.7\times2} \times \frac{12}{2\times10^9} + \frac{2.56\times10^8\times5}{2\times10^9} = 3.84s$

Eight processors: $T = \Sigma$ (Count × CPI × Cycle Time)

$= \frac{2.56\times10^9}{0.7\times8} \times \frac{1}{2\times10^9} + \frac{1.28\times10^9}{0.7\times4} \times \frac{12}{2\times10^9} + \frac{2.56\times10^8\times5}{2\times10^9} = 2.24s$

2 processors: relative speed up $= \frac{\text{2-processors}}{\text{single-processor}} = \frac{7.04}{9.6} = 0.73$

4 processors $= \frac{3.84}{9.6} = 0.4$ or $\frac{9.6}{3.84} = 2.5$ or $\frac{\text{single}}{\text{two}} = \frac{9.6}{7.04} = 1.36$

8 processors $= \frac{2.24}{9.6} = 0.23$ or $\frac{9.6}{2.24} = 4.29$

1.9, 1.11

2.5 1.92: single processor: CPU Time1 = Count × CPI × Cycle Time

$= \frac{2.56\times10^9}{} \times 2 \times \frac{1}{2\times10^9} = 2.56\,s.$

CPU Time2 = Count × CPI × Cycle Time

$= \frac{1.28\times10^9}{} \times 12 \times \frac{1}{2\times10^9} = 7.68\,s$

CPU Time3 $= 2.56\times10^8 \times 5 \times \frac{1}{2\times10^9} = 0.64\,s$

$\therefore T = 2.56 + 7.68 + 0.64 = 10.88$

Two processors: $T = \sum_{i=1}^{3}$ CPU Time$_i$ $= \Sigma$ (Count × CPI × Cycle Time)

$= \frac{2.56\times10^9}{0.7\times2} \times 2 \times \frac{1}{2\times10^9} + \frac{1.28\times10^9}{0.7\times2} \times 12 \times \frac{1}{2\times10^9} + 2.56\times10^8 \times 5 \times \frac{1}{2\times10^9}$

$= 7.95\,s$

Four processors: $T = \Sigma$ (Count × CPI × Cycle Time)

$= \frac{2.56\times10^9}{0.7\times4} \times \frac{2}{2\times10^9} + \frac{1.28\times10^9}{0.7\times2} \times \frac{12}{2\times10^9} + \frac{2.56\times10^8\times5}{2\times10^9} = 4.30\,s$

Eight processors: $T = \Sigma$ (Count × CPI × Cycle Time)

$= \frac{2.56\times10^9}{0.7\times8} \times \frac{2}{2\times10^9} + \frac{1.28\times10^9}{0.7\times4} \times \frac{12}{2\times10^9} + \frac{2.56\times10^8\times5}{2\times10^9} = 2.47\,s$

1	single	two	four	eight
before	9.6	7.04	3.84	2.24
After	10.88	7.95	4.30	2.47
before / After	0.88	0.89	0.89	0.91

So the execution time increase.

1.93 So the CPU Time will be 3.84 S.

since the arithmetic time is 1.28 s

the branch instruction time is 0.64 s

So $t_2 = 3.84 - 1.28 - 0.64 = 1.92\,s$

$\therefore CPI = \frac{1.92\times2\times10^9}{1.28\times10^9} = 3$

1.11 ① execution time = count × CPI × Cycle time ∴ CPI =

$750 = 2.389\times10^{12}\times CPI\times 0.333\times10^{-9}$ 0.943S

② SPECratio = $\frac{\text{reference time}}{\text{execution time}} = \frac{9650s}{750s} = 12.87$

③ CPU Time = Count × CPI × Cycle Time

$= 2.389\times10^{12}\times1.1\times0.943\times0.333\times10^{-9}$

$\approx 825.21S$

$\Delta = 825.21 - 750 = 75.21S$

④ CPU Time = Count × CPI × Cycle time

$= 2.389\times10^{12}\times1.1\times0.943\times1.05\times0.333\times10^{-9}$

$\approx 866.47S$

⑤ SPECratio = $\frac{\text{reference time}}{\text{execution time}} = \frac{9650s}{866.47s} \approx 11.14S.$

⑥ execution time = count × CPI × cycle time

$700 = 2.389\times10^{12}\times85\%\times CPI\times\frac{1}{4\times10^9}$

CPI = 1.38S

⑦ $\frac{4}{3} = 1.33 \div \frac{1.38}{0.943} \approx 1.46$ So there are not similar. since we also decrease the number of instructions.

⑧ decrease = $\frac{700}{750} = 0.93$ $\frac{50}{750}\times100\% = 6.67\%$. So it has decreased about 6.67%.

⑨ execution time = count × CPI × Cycle time.

$960\times10^{-9}\times90\% = count\times1.61\times\frac{1}{4\times10^9}$

count ≈ 2147.

⑩ $960\times10^{-9}\times90\%\times90\% = 2147\times1.61\times\frac{1}{\text{clock rate}}$.

clock rate = 4.4453 GHz

relative to original execution time 960ns.

⑪ $960\times10^{-9}\times80\% = 2147\times1.61\times85\%\times\frac{1}{\text{clock rate}}$

clock rate = 3.83 GHz