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Example 1

Measurements
- Frequency of FP operations = 25%
- CPI for FP operations = 4.0 clock cycles
- CPI for all other instructions = 1.33 c.c.
- Frequency FPSQRT = 2%
- CPI of FPSQRT = 20 c.c.

IC, clock cycle time - unchanged

$CPI_{original} = \sum_{i=1}^{n} CPI_i \times \frac{IC_i}{IC}$

FP / non-FP $\Rightarrow i = 2$

$CPU\ time_A = IC \times CPI \times CCT_A$

$CPI_{original} = 4 \times 25\% + 1.33 \times 75\% = 2$ c.c.

$CPI_A = CPI_{original} - (20-2) \times 2\% = 2 - 18 \times 0.02 = 1.64$ c.c

$CPI_B = 75\% \times 1.33 + 25\% \times 2.5 = 1.62$ c.c.

2 Alternatives of design
- (A) - decrease CPI of FPSQRT to 2 c.c. Speedup = $\frac{20}{2} = 10$
- (B) - decrease CPI of all FP instructions to 2.5 c.c. Speedup = $\frac{4}{2.5} = 1.6$

$CPU\ time_A > CPU\ time_B$

$Performance_A < Performance_B$

Example 2 Branch instructions

machine A → CPU_A

CMP R1, R2
BEQ address

machine B → CPU_B

BCMP R1, R2, address

Clock cycle time$_B$ = 1.25 × Clock cycle time$_A$

20% instructions are branches (cond.)
other 20% instructions are compare instructions

$CPI_{branch} = 2$ c.c
$CPI_{others} = 1$ c.c.

$CPI_A = 0.2 \times 2 + 0.8 \times 1 = 1.2$ c.c.

$CPU\ time_A = IC_A \times 1.2 \times$ Clock cycle time$_A$

Clock cycle time$_B$ = 1.25 × Clock cycle time$_A$

$IC_B = 0.8 \times IC_A$

20% branches ... 80% instructions
x ... 100%
$x = \frac{100 \times 2}{80} = \frac{200}{80} = 25\%$

$CPI_B = 0.25 \times 2 + 0.75 \times 1 = 1.25$

$CPU\ time_B = IC_A \times 0.8 \times 1.25 \times 1.25 \times CCT_A$

$= IC_A \times 1.25 \times CCT_A$

~~$CPU\ time_B > CPU_1$~~

$CPU\ time_A < CPU\ time_B$

$Performance_A > Performance_B$