6.6 Parallelism and performance

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

KEY WORDS instruction-level parallelism • SMT

Objective

Apply Amdahl's law exactly, and price a speedup before buying hardware.

1 Key knowledge and worked examples

■ The law

Speedup $= 1/((1-f)+f/p)$; the ceiling as p grows is $1/(1-f)$: $f = 0.9$ caps every machine at $10\times$ ✓.

■ Worked example: exact points

$f = 0.9$: $p = 8$ gives $4.71\times$, $p = 16$ gives $6.40\times$; $f = 0.99$ hits exactly $50\times$ at $p = 99$ ✓.

2 Practice

2.1 $f = 0.8$: state the ceiling. [3]

2.2 $f = 0.75$, $p = 3$: compute the speedup to two decimals. [3]

2.3 Name the three rungs of the parallelism ladder. [3]

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3 Exam-style questions

3.1 A workload spends 12 s serial and 88 s parallelizable on one core.

Compute f. Compute the speedup and runtime on $p = 4$ and $p = 16$. Compute the smallest p that reaches a $4\times$ speedup (solve $1/((1-f)+f/p) \geq 4$ for p). State the ceiling and what it means for a planned 64-core purchase. [8]

3.2 Two optimisations are proposed for a program that runs 50 s: A parallelises 90% of the time on 8 cores; B cuts the serial 10% remaining time in half.

Compute A's speedup and new runtime. Compute B's speedup and new runtime (no parallelism). Compute the combined effect of A then B, and state which single change a buyer should prefer at 8 cores, with the reason in one line. [7]

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