# Tikili David Nimibofa

# (20101)

**5/25/2024**

**Individual Assignment 1**

1. (1) fprocessing = 0.2

fdisk = 0.3

fnetwork = 0.5

Base system can handle 10,000 web page accesses/sec and costs $5k.

**Amdahl’s Law,**

𝑆 = 1

(1−𝑓)+ 𝑓

𝑘

* 1. **Option 1: Replacing the disk with a disk supporting 40 Mbytes/sec with an additional cost of $1000,**

The disk speedup , kdisk = 40/20 =2

Using Amdahl’s law, S = 1 = 1.176

1 (1−0.3)+ 0.3

2

New performance = 1.176 x 10000 = 11760 web page accesses/sec

* 1. **Option 2 : Replacing the processor with an 800 MHz processor with an additional cost of**

**$800**,

The processor speedup, kprocessor = 800/500 = 1.6

Using Amdahl’s law, S2

= 1 = 1.081

(1−0.2)+ 0.2

1.6

New performance = 1.081 x 10000 = 10810 web page accesses/sec

* 1. **Option 3 : Using both enhancements with an additional cost of $1500,**

1

S = = 1.29

3 (1−(0.3+0.2))+ 0.3 + 0.2

2 1.6

New performance = 1.29 x 10000 = 12900 web page accesses/sec

𝐴𝑑𝑑𝑖𝑡𝑖𝑜𝑛𝑎𝑙 𝑐𝑜𝑠𝑡

(2) **cost-performance ratio =**

𝑃𝑒𝑟𝑓𝑜𝑟𝑚𝑎𝑛𝑐𝑒 𝑖𝑚𝑝𝑟𝑜𝑣𝑒𝑚𝑒𝑛𝑡

1. **Option 1: Replacing the disk with a disk supporting 40 Mbytes/sec with an additional cost of $1000,**

Performance improvement = 11760 - 10000 = 1760 cost-performance ratio = 1000 = 0.568

1760

1. **Option 2 : Replacing the processor with an 800 MHz processor with an additional cost of**

**$800,**

Performance improvement = 10810 - 10000 = 810 cost-performance ratio = 800 = 0.988

810

1. **Option 3 : Using both enhancements with an additional cost of $1500,**

Performance improvement = 12900 - 10000 = 2900 cost-performance ratio = 1500 = 0.517

2900

Based on the cost-performance analysis, **option 3**(using both enhancements) has the lowest cost-performance ratio of **0.517**, making it the best cost-effective choice.

1. f - fraction of work performed on the enhanced component k - speedup factor of the enhanced component

fd - fraction of work performed by dependent component sd - slowdown factor of the dependent component

To derive the parameterized speed-up equations for each of the given options, we'll take into account both the speedup of the enhanced component and the slowdown of the dependent component.

# Modified Amdahl’s law that includes the negative impact on the dependent component,

**S =**  1

(1−𝑓−𝑓𝑑) + 𝑓 +𝑓𝑑.𝑠𝑑

𝑘

# Option A :

Speedup of component A, kA = 10 Fraction of instructions using A, fA = f Slowdown of component B, sB = 5

Fraction of instructions using B affected by A, fB = 2 . f The speedup equation for Option A is

1

S =

A (1−𝑓−2𝑓)+ 𝑓 +2𝑓.5

10

1

**=**

**S**

**A** 1+6.9𝑓

# Option B :

Speedup of component B, kB = 20 Fraction of instructions using B, fB = f Slowdown of component A, sA = 2

Fraction of instructions using A affected by B, fA = 0.5 . f The speedup equation for Option B is

1

S =

B (1−𝑓−0.5𝑓)+ 𝑓 +0.5𝑓.2

20

**S =**  1

**B** 1−0.45𝑓

# Option C :

Speedup of component A, kA = 4 Fraction of instructions using A, fA = f Slowdown of component B, sB = 1.8

Fraction of instructions using B affected by A, fB = f The speedup equation for Option C is

1

S =

C (1−𝑓−𝑓)+ 𝑓 +𝑓. 1.8

4

**S =**  1

**C** 1−1.55𝑓

1. Option A : **SA**

**=**

1 1+6.9𝑓

Option A offers a significant speed-up SA with the speedup factor of component A being 10. However, it also imposes a slowdown factor of 5 on the dependent component B, affecting a fraction of 2f of its instructions. This means that while component A sees a substantial improvement, component B experiences a considerable slowdown due to the dependency.

Option B : **S =**  1

**B** 1−0.45𝑓

Option B offers a moderate speed-up SB with the speedup factor of component B being 20. However, it imposes a smaller slowdown factor of 2 on the dependent component A, affecting a fraction of 0.5f of its instructions.

Option C : **S**

**=**  1

**C** 1−1.55𝑓

Option C offers a modest speed-up SC the speedup factor of component A being 4. It imposes a slowdown factor of 1.8 on the dependent component B, affecting the same fraction (f) of its instructions as component A.

**Option B** may be the preferred choice for a beginner architect. It offers a significant speedup for component B while imposing a relatively small slowdown on component A. This option provides a more predictable performance improvement and is less sensitive to variations in the workload distribution between components A and B compared to the other options.

1. **Amdahl’s Law,**

𝑆 = 1

(1−𝑓)+ 𝑓

𝑘

# System 1,

f1 = 0.45

1

𝐸𝑥𝑒𝑐𝑢𝑡𝑖𝑜𝑛 𝑡𝑖𝑚𝑒 𝑤𝑖𝑡ℎ𝑜𝑢𝑡 𝑒𝑛ℎ𝑎𝑛𝑐𝑒𝑚𝑒𝑛𝑡

=

k

1 𝐸𝑥𝑒𝑐𝑢𝑡𝑖𝑜𝑛 𝑡𝑖𝑚𝑒 𝑤𝑖𝑡ℎ 𝑒𝑛ℎ𝑎𝑛𝑐𝑒𝑚𝑒𝑛𝑡

## S = 1 = 1.68

1 0.45

(1−0.45)+

10

=  10 = 10

# System 2,

f2 = 0.35

2

𝐸𝑥𝑒𝑐𝑢𝑡𝑖𝑜𝑛 𝑡𝑖𝑚𝑒 𝑤𝑖𝑡ℎ𝑜𝑢𝑡 𝑒𝑛ℎ𝑎𝑛𝑐𝑒𝑚𝑒𝑛𝑡

=

k

2 𝐸𝑥𝑒𝑐𝑢𝑡𝑖𝑜𝑛 𝑡𝑖𝑚𝑒 𝑤𝑖𝑡ℎ 𝑒𝑛ℎ𝑎𝑛𝑐𝑒𝑚𝑒𝑛𝑡

## S = 1 = 1.33

2 0.35

(1−0.35)+

3.5

=  7 = 3.5

# System 3,

f3 = 0.20

1.5

𝐸𝑥𝑒𝑐𝑢𝑡𝑖𝑜𝑛 𝑡𝑖𝑚𝑒 𝑤𝑖𝑡ℎ𝑜𝑢𝑡 𝑒𝑛ℎ𝑎𝑛𝑐𝑒𝑚𝑒𝑛𝑡

=

k

3 𝐸𝑥𝑒𝑐𝑢𝑡𝑖𝑜𝑛 𝑡𝑖𝑚𝑒 𝑤𝑖𝑡ℎ 𝑒𝑛ℎ𝑎𝑛𝑐𝑒𝑚𝑒𝑛𝑡

## S = 1 = 1.16

3 0.20

(1−0.20)+

3.33

=  5.0 = 3.33

Comparing the speedups, System 1 has the highest speedup and will provide the best performance for the laboratory.

# System 1:

Cost = $8000

Performance Speedup S1 = 1.68

Cost-performance ratio = 8000 = 4761.90

1.68

# System 2:

Cost = $5000

Performance Speedup S2 = 1.33

Cost-performance ratio = 5000 = 3759.40

1.33

# System 3:

Cost = $6500

Performance Speedup S3 = 1.16

Cost-performance ratio = 6500 = 5603.45

1.16

Comparing the cost-performance ratio, **System 2** has the lowest ratio, and provides a reasonable balance between cost and performance.

S