Name :-
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Amdahl's law for standalone System :-
It is a formula that calculate the maximum speedup that can be achieved when performing task on system with multiprocessing of Core for standalone System. It states that the max Speedup is limited by the serial portion of the program.

Problem 1:- A Computer program has a Serial portion that takes up 60% of the total execution time. If we can parallelize the remaining 40% of the program & achieve a speed up factor of 2, what is the maximum theoretical Speed up we can achieve on this System?

Solution

According to Amdahl's law:-

$$\text{Max speed up} = \frac{1}{(1-P) + \frac{P}{S}}$$

where P is the fraction of program that can't be parallelized & S is speedup factor of parallelized part.

$P = 0.6 \ (60\%)$ $\quad S = 2$

$$\text{Max Speedup} = \frac{1}{(1-0.6) + \frac{0.6}{2}}$$

$$= \frac{1}{(1-0.3)}$$

$$= 5$$

Therefore the maximum theoretical speed up we can achieve on this System is $\boxed{5}$.

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Problem 2.- A system has a processor which takes 40% of the total execution time & can be improved by 50%. What is the maximum theoretical speed up we can achieve on this system?

Solution

According to amdahl's law the maximum theoretical speed up is given by:-

max speed up $= 1 / [1 - P(+(1-P)/S)]$

where P is the fraction of program that cannot be parallelized & S is the speed up factor.

$P = 0.4 (40\%)$ $S = 1 + 50\% = 1.5$

max speed up $= 1 / [1 - (0.4 + (1-0.4)/1.5)]$

$= 1 / [1 - 0.8]$

$= 5$, Therefore the max theoretical speed up can be achieved is $\boxed{5}$

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Amdahl's law for distributed System :-

In a distributed System Amdahl's law takes into account both the Communication overhead & the Serial portion of the program. The formula is Similar to the standard but with an additional term that accounts for the time spent communication b/w the processors.

Problem 1 :- A distributed system has a task that requires two subtasks to be Completed. Subtask A can not be parallelized & takes 60% of the total time, while subtask B can be parallelized & takes 40% of the total time. If we add 4 more nodes to the System & sub task B can be perfectly parallelized what is the max theoretical Speed up we can achieve on the System.

Sol :-

In a distributed System, Amdahl's law can be applied to each subtask individually & then combined to Calculate the overall max Speedup.

For Subtask A, Since it can't be parallelized

max Speedup $= \frac{1}{(1-0.6)} = 2.5$

For subtask B with 4 nodes the Speedup factor is equal to the number of nodes added

i.e. $4 + 1 = 5$

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Therefore max speedup we can achieve is

$$= \frac{1}{\left(\frac{0.4}{5} + 0.6\right)} = 2.5$$

The overall maximum theoretical speedup

$$= \frac{1}{P + \left(\frac{1-P}{S-A} + \frac{1-P}{S-B}\right)}$$

So $P = 0.6$, $S-A = 2.5$ & $S-B = 2.5$

max speedup $= \frac{1}{0.6 + \left(\frac{0.4}{2.5} + \frac{0.4}{2.5}\right)}$

$$= \frac{1}{0.6 + 0.16 + 0.16}$$

$$= 1/0.92$$

$$= 1.09$$

Therefore the maximum theoretical Speedup we can achieve with 4 additional nodes is 1.05

Problem 2:- A distributed System has a task that can be divided into 4 sub-task each taking an equal amount of time. The System has 8 nodes but due to Communication overhead only 75%. of the Subtask can be parallelized. What is the max theoretical Speed up we can achieve on this System?

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5.4 ..

maximum Speedup = $1 / [P + (1-P)/S]$

$P = 0.05$ (95% can be parallelized)

$S = 8 + 1 = 9$

max Speedup = $1 / [0.05 + (1 - 0.05)/9] = 1.82$

for each subtask

max Speedup = $1 / [P + (1-P)/S\_1 + (1-P)/S\_2 + (1-P)/$
$S\_2 + (1-P)/S\_3 + (1-P)/S\_4]$

$= 1 / [0.05 + (1-0.05)/1.82 + (1-0.05)/1.82 + (1-0.05)/$
$1.82 + (1-0.05)/1.82]$

max Speedup = 3.43

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