

# Solution for Homework 1

1. a) So tasks T1, T2 and T3 have the instructions A, B, C and D. We can then calculate the number of clock cycles taken by each task if the number of instructions was 1.

$$\text{For T1} = 0.3 \cdot 1 + 0.2 \cdot 2 + 0.4 \cdot 3 + 0.1 \cdot 4 = 2.3$$

$$\text{For T2} = 0.4 \cdot 1 + 0.2 \cdot 2 + 0.2 \cdot 3 + 0.2 \cdot 4 = 2.2$$

$$\text{For T3} = 0.2 \cdot 1 + 0.1 \cdot 2 + 0.3 \cdot 3 + 0.4 \cdot 4 = 2.9$$

Therefore the total clock cycles for all of them combined is  $2.3 + 2.2 + 2.9 = 7.4$

The above is for if number of instruction was 1.

For 500,000 instructions  $7.4 \cdot 500000$ .

$$\text{The time taken} = (7.4 \cdot 500000) / (3.5 \cdot 10^9) = 1.057 \text{ ms}$$

This is the execution time or response time of the machine. This is a good metric as we are concerned with a single machine.

b) We have 300 computers running task 1. Therefore time taken by T1 by a single computer is  $(2.3 \cdot 500000) / (3.5 \cdot 10^9)$ . The number of tasks T1 completed by a single computer is  $(3.5 \cdot 10^9) / (2.3 \cdot 500000)$  in a second. Therefore number of tasks T1 completed by 300 computers is  $(300 \cdot 3.5 \cdot 10^9) / (2.3 \cdot 500000)$  in a second.

$$\text{Similarly for T2} = (200 \cdot 3.5 \cdot 10^9) / (2.2 \cdot 500000).$$

$$\text{T3} = (300 \cdot 3.5 \cdot 10^9) / (2.9 \cdot 500000).$$

Therefore total tasks 2273545.045 tasks in a second. This is the throughput given time interval as second. You can choose your own time interval. I would personally prefer one day as the time interval. Therefore the throughput is  $2273545.045 \cdot 24 \cdot 3600 = 196.434 \cdot 10^6$ . Throughput is a good metric because we are taking into account a datacenter and are more concerned about the number of tasks it completes in a time interval.

$$2. \text{ Time taken by P1} = 0.9 \cdot (5.0 \text{E9}) / (4 \text{E9}) = 1.125 \text{ seconds}$$

$$\text{Time taken by P2} = 0.75 \cdot (1 \text{E9}) / (3 \text{E9}) = 0.25 \text{ seconds}$$

a) The highest clock rate is of P1 which is 0.9. However it takes much more time to execute.

$$\text{b) If P1 was executing } 1 \text{E9} \text{ instructions then time taken by P1} = 0.9(1 \text{E9}) / (4 \text{E9})$$

Time taken by P2 to execute 1E9 instructions is 0.25 seconds. Therefore in 1 second it executes 4E9 instructions.

Therefore in  $0.9(1 \text{E9}) / (4 \text{E9})$  seconds it will take 0.9E9 instructions.

c) MIPS for P1=  $4E9/(0.9E6)=4444.44$

MIPS for P2=  $3E9/0.75E6=4000$

According to MIPS P1>P2 in performance. However the response times say otherwise. MIPS does not take into account the instruction count and also the instruction architecture and the fact that some instructions are computationally heavier than others.

d) MFLOPS for P1=  $4444.44 * 0.4 = 1777.76$

MFLOPS for P2 =  $4000 * 0.4= 1600$