Chapter 1 Solutions - excerpt

1.1 a. Yield= $1/(1+(0.04\times 2))^{14} = 0.34$

b. It is fabricated in a larger technology, which is an older plant. As plants age, their process gets tuned, and the defect rate decreases.

1.2 a. Phoenix:

$$\text{Dies per wafer} = \pi\times(45/2)^2\ /2 - (\pi\times 45)/\text{sqrt}(2\times 2) = 795 - 70.7 = 724.5 = 724$$

$$\text{Yield} = 1/(1+(0.04\times 2))^{14} = 0.340$$

$$\text{Profit} = 724\times 0.34\times 30 = \$7384.80$$

b. Red Dragon:

$$\text{Dies per wafer} = \pi\times(45/2)^2\ /2 - (\pi\times 45)/\text{sqrt}(2\times 1.2) = 1325 - 91.25 = 1234$$

$$\text{Yield} = 1/(1+(0.04\times 1.2))^{14} = 0.519$$

$$\text{Profit} = 1234\times 0.519\times 15 = \$9601.71$$

c. Phoenix chips: 25,000/724 = 34.5 wafers needed
Red Dragon chips: 50,000/1234 = 40.5 wafers needed

Therefore, the most lucrative split is 40 Red Dragon wafers, 30 Phoenix wafers.

1.4 a. Energy: 1/8. Power: Unchanged.

b. Energy: $\text{Energy}_{new}/\text{Energy}_{old} = (\text{Voltage}\times 1/8)^2/\text{Voltage}^2 = 0.156$
Power: $\text{Power}_{new}/\text{Power}_{old} = 0.156\times(\text{Frequency}\times 1/8)/\text{Frequency} = 0.00195$

c. Energy: $\text{Energy}_{new}/\text{Energy}_{old} = (\text{Voltage}\times 0.5)^2/\text{Voltage}^2 = 0.25$
Power: $\text{Power}_{new}/\text{Power}_{old} = 0.25\times(\text{Frequency}\times 1/8)/\text{Frequency} = 0.0313$

d. 1 core= 25% of the original power, running for 25% of the time.

$$0.25\times 0.25 + (0.25\times 0.2)\times 0.75 = 0.0625 + 0.0375 = 0.1$$

GPU: $1/(0.4/2.46 + 0.1/2.76 + 0.5/1.25) = 1.67$
TPU: $1/(0.4/41 + 0.1/21.2 + 0.5/0.17) = 0.33$

e. General-purpose: 14,000/504 = 27.8 ≥ 28
GPU: 14,000/1838 = 7.62 ≥ 8
TPU: 14,000/861 = 16.3 ≥ 17

d. General-purpose: 2200/504 = 4.37 ≥ 4, 14,000/(4 × 504) = 6.74 ≥ 7
GPU: 2200/1838 = 1.2 ≥ 1, 14,000/(1 × 1838) = 7.62 ≥ 8
TPU: 2200/861 = 2.56 ≥ 2, 14,000/(2 × 861) = 8.13 ≥

1.8 a. 50%

b. Energy: $\text{Energy}_{new}/\text{Energy}_{old} = (\text{Voltage}\times 1/2)^2/\text{Voltage}^2 = 0.25$

1.15 a. $1/(0.5+0.5/22) = 1.91$

b. $1/(0.1+0.90/22) = 7.10$

c. $41\% \times 22 = 9$. A runs on 9 cores. Speedup of A on 9 cores: $1/(0.5+0.5/9) = 1.8$ Overall speedup if 9 cores have 1.8 speedup, others none: $1/(0.6+0.4/1.8) = 1.22$

d. Calculate values for all processors like in c. Obtain: 1.8, 3, 1.82, 2.5, respectively.