CHAP-1

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Eight great ideas in computer architecture:

i) Design for Moore's Law.
ii) use Abstraction to simplify Design.
iii) Make the common case Fast.
iv) performance via parallelism.
v) performance via pipelining.
vi) performance via prediction.
vii) Hierarchy of memories.
viii) Dependability via Redundancy.

Five classic components of computer:

i) Input
ii) output
iii) memory
iv) Datapath
v) control

sometimes combined of datapath and control are called Processor.

Pixels:

The pixel is the basic unit of programmable color on a computer display or in a computer image.

Bit map:

The image is composed of a matrix of picture elements, or pixels, which can be represented as a matrix of bits, called a bit map.

Frame Buffer:

A framebuffer is a portion of RAM containing a bitmap that drives a video display.

Integrated circuit (IC):

An integrated circuit (IC) sometimes called a chip or microchip, is a semiconductor wafer on which thousands or millions of tiny resistors, ~~are fabricated~~. capacitors and transistors are fabricated.

Datapath:

Datapath is the component of the processor that performs arithmatic operation.

Cache memory:

Cache memory is a small, fast memory that acts as a buffer for the DRAM memory.

Wafer:

A thin slice of silicon crystal.

Die:

Die is the individual rectangular sections that are cut from a wafer.

Yield:

Yield is the percentage of good dies from the total number of dies on the wafer.

CPI:

CPI is the average number of clock cycles each instruction takes to execute.

Instruction count:

Instruction count is the number of instructions executed by the program.

MIPS:

MIPS is a measurement of program execution speed based on the number of millions of instruction.

$$MIPS = \frac{\text{Instruction count}}{\text{Execution time} \times 10^6}$$

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1.10

P→57 ⊕ Assume a 15 cm diameter wafer has a cost of 12, contain 84 dies, and has 0.020 defects/cm^2. Assume a 20 cm diameter wafer has a cost of 15, contains 100 dies, and has 0.031 defects/cm^2.

i) Find the yield for both wafers.
ii) Find the cost per die for both wafers.
iii) If the number of dies per wafer is increased by 10% and the defects per area unit increased by 15%, find the die area and yield.

⊕ Formula:

(i) $$\text{cost per die} = \frac{\text{cost per wafer}}{\text{Dies per wafer} \times \text{yield}}$$

(ii) $$\text{Dies per wafer} = \frac{\text{wafer area}}{\text{Die area}}$$

(iii) $$\text{yield} = \frac{1}{(1+(\text{Defects per area} \times \text{Die area}/2))^2}$$

Solve:

1) For the first wafer:

$$\text{wafer area} = \pi r^2$$

$$= \pi \times (15/2)^2$$

$$= 3.1416 \times (7.5)^2$$

$$= 176.715 \text{ cm}^2$$

$$\therefore \text{Die area} = \frac{\text{wafer area}}{\text{Dies per wafer}}$$

$$= \frac{176.715 \text{ cm}^2}{84}$$

$$= 2.104 \text{ cm}^2$$

$$\therefore \text{yield} = \frac{1}{(1+(\text{defects per area} \times \text{Die area}/2))^2}$$

$$= \frac{1}{(1+(0.020 \times 2.104/2))^2}$$

$$= \frac{1}{1.0425}$$

$$= 0.96 \quad \text{(Ans)}$$

For the second wafer:

$$\text{wafer area} = \pi r^2$$

$$= \pi \times \left(\frac{20}{2}\right)^2$$

$$= 3.1416 \times (10)^2$$

$$= 314.16 \text{ cm}^2$$

$$\therefore \text{Die area} = \frac{\text{wafer area}}{\text{Dies per wafer}}$$

$$= \frac{314.16 \text{ cm}^2}{100}$$

$$= 3.1416 \text{ cm}^2$$

$$\therefore \text{yield} = \frac{1}{(1 + (\text{defects per area} \times \text{Die area}/2))^2}$$

$$= \frac{1}{(1 + (0.031 \times 3.1416/2))^2}$$

$$= \frac{1}{1.0998}$$

$$= 0.91 \text{ (Ans)}$$

ii) For the first wafer:

$$\text{cost per die} = \frac{\text{cost per wafer}}{\text{Dies per wafer} \times \text{yield}}$$

$$= \frac{12}{84 \times 0.96}$$

$$= 0.1488 \quad \text{(Ans)}$$

For the second wafer:

$$\text{cost per die} = \frac{\text{cost per wafer}}{\text{Dies per wafer} \times \text{yield}}$$

$$= \frac{15}{100 \times 0.91}$$

$$= 0.165 \quad \text{(Ans)}$$

iii) By increasing dies per wafer by 10%, we get,

For the first wafer $= \left(84 + \frac{84 \times 10}{100}\right) = 92.4$

For the second wafer $= \left(100 + \frac{100 \times 10}{100}\right) = 110$

By increasing defects per area by 15%, we get,

For the first wafer $= \left(0.020 + \frac{0.020 \times 15}{100}\right)$

$= 0.023$

For the second wafer $= \left(0.031 + \frac{0.031 \times 15}{100}\right)$

$= 0.0357$

For the first wafer:

$$\text{Die area} = \frac{\text{wafer area}}{\text{Dies per wafer}}$$

$$= \frac{176.715 \text{ cm}^2}{92.4} = 1.913 \text{ cm}^2 \text{ (Ans)}$$

$$\text{yield} = \frac{1}{(1+(\text{defects per area} \times \text{Die area}/2))^2}$$

$$= \frac{1}{(1+(0.023 \times 1.913/2))^2}$$

$$= \frac{1}{1.04448}$$

$$= 0.957 \text{ (Ans)}$$

For the second wafer:

$$\text{Die area} = \frac{\text{wafer area}}{\text{Dies per wafer}}$$

$$= \frac{314.16 \text{ cm}^2}{110}$$

$$= 2.856 \text{ cm}^2 \quad \text{(Ans)}$$

$$\text{yield} = \frac{1}{(1+(\text{defects per area} \times \text{Die area}/2))^2}$$

$$= \frac{1}{(1+(0.0357 \times 2.856/2))^2}$$

$$= \frac{1}{1.1046}$$

$$= 0.905 \quad \text{(Ans)}$$

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1.4

355 Assume a color display using 8 bits for each of the primary colors (R, G, B) per pixel and a frame size of 1280X1024.

i) What is the minimum size in bytes of the frame buffer to store a frame?

ii) How long would it take, at a minimum, for the frame to be sent over a 100 mbit/s network?

Solve:

i) Given that,

$$\text{frame size} = (1280 \times 1024) \text{ pixels}$$
$$= 1310720 \text{ pixels}$$
$$= (1310720 \times 24) \text{ bit/frame}$$
$$= 31,457,280 \text{ bit/frame}$$
$$= (31,457,280/8) \text{ bytes/frame}$$
$$= 3932160 \text{ bytes/frame.}$$

(Ans)

ii) $100 \text{ mbit/s} = 100 \times 10^6 \text{ bit/s}$

100×10^6 bit sent over a network for 1 second

$\therefore$ 1 " " " " " " $\frac{1}{100 \times 10^6}$ "

$\therefore$ 31,457,280 " " " " " " $\frac{31,457,280}{100 \times 10^6}$ "

$= 0.31$ second

(Ans)