

Ex 1: MM Size: 4 GB
Cache Size: 1 MB
Block Size: 4 KB

Sol. MM Size = 4 GB

1. P.A. bits' split?
2. Tag directory size?

1 Byte = 8 bits
1 KB = 1024 Bytes = 2^{10} B
1 MB = 1024 KB = 2^{20} B
1 GB = 1024 MB = 2^{30} B

Sol. MM Size = 4 GB = $2^2 \times 2^{30}$ B

1 Byte = 8 bits
1 KB = 1024 Bytes = 2^{10} B
1 MB = 1024 KB = 2^{20} B
1 GB = 1024 MB = 2^{30} B

Sol. MM Size = 4 GB = $2^2 \times 2^{30}$ B = $2^{(2+30)}$ B = 2^{32} B

\therefore No. of P.A. bits = $\log_2 2^{32} = 32$

← 32 bits →

Block Size = 4 KB = $2^2 \times 2^{10}$ B = 2^{12} B

No. of Blocks in MM = $2^{32} / 2^{12} = 2^{20}$

\therefore Block number bits = $\log_2 2^{20} = 20$

\therefore Block offset = $\log_2 2^{12} = 12$

← 32 bits →
20 bits 12 bits

Cache Size = 1 MB = 1×2^{20} B = 2^{20} B

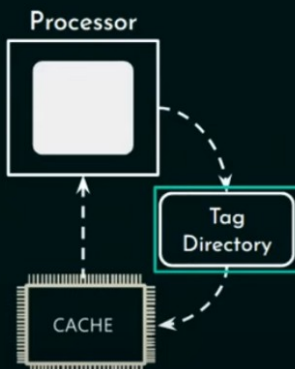
No. of Lines in Cache = $2^{20} / 2^{12} = 2^8$

\therefore Line number bits = $\log_2 2^8 = 8$

← 32 bits →
20 bits
12 bits 8 bits 12 bits

No. of Tag bits : P.A. bits - (Line no. bits + offset) = $32 - (8+12) = 12$

Sol.



Tag directory:

- Keeps primarily the record of Tag bits, cache line-wise.
- No. of entries = No. of Cache lines.

← 32 bits →
20 bits
Tag Line B/L offset
12 bits 8 bits 12 bits

No. of Lines in Cache = 2^8

No. of Tag bits = 12

Tag directory size = $2^8 \times 12$ bits = 3072 bits ←

Ex 2: MM Size: 256 MB
Cache Size: 512 KB

● No. of tag bits?

Sol. Tag bits: Identifies the MM block residing in the Cache Line.

Block Size = Line Size

$\log_2 (\text{MM Size} : \text{Cache Size})$

$$\begin{aligned}\text{MM Size} &= 256 \text{ MB} \\ &= 2^8 \times 2^{20} \text{ B} \\ &= 2^{28} \text{ B}\end{aligned}$$

$$\begin{aligned}\text{Cache Size} &= 512 \text{ KB} \\ &= 2^9 \times 2^{10} \text{ B} \\ &= 2^{19} \text{ B}\end{aligned}$$

$$\begin{aligned}\therefore \text{No. of Tag bits} : \log_2 (2^{28} / 2^{19}) &= \text{Log}_2 2^{(28-19)} \\ &= \text{Log}_2 2^9 = 9 \leftarrow\end{aligned}$$

Ex 3: **Byte-addressable MM Size: 16 GB**
Block Size: 16 KB
No. of Tag bits: 10

● **Cache size?**

Sol. MM Size = 16 GB = $2^4 \times 2^{30}$ B = 2^{34} B
 \therefore No. of P.A. bits = $\log_2 2^{34} = 34$
 Block Size = 16 KB = $2^4 \times 2^{10}$ B = 2^{14} B
 \therefore **Block offset** = $\log_2 2^{14} = 14$



No. of **Line number** bits : P.A. bits - (Tag bits + offset) = 34 - (10+14) = 10

\therefore No. of **Cache Lines** = 2^{10}

Line Size = 2^{14} B

Cache Size = $2^{10} \times 2^{14}$ B = $2^{(10+14)}$ B = 2^{24} B = $2^4 \times 2^{20}$ B = **16 MB** ←

<https://www.youtube.com/watch?v=OxaYvJquPe0>