1. **MM Size: 4 GB**

**Cache Size: 1 MB**

**Block Size: 4 KB**

**Word Size: 1 Byte**

**Find the P.A Bit split, No of Tag Bits, and Tag Directory Size.**

MM = 4 GB = 2² x 2³⁰ B = 2⁽²⁺³⁰⁾ B = 2³² B

∴ No. of P.A. bits = log₂ 2³² = 32

Block Size = 4 KB = 2² x 2¹⁰ B = 2¹² B

No. of Blocks in MM = 2³² / 2¹² = 2²⁰

∴ Block number bits = log₂ 2²⁰ = 20

Cache Size = 1 MB = 1 x 20²⁰ B = 2²⁰ B

No. of Lines in Cache = 2²⁰ / 2¹² = 2⁸

∴ Line number bits = log₂ 2⁸ = 8

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

1. **MM Size = 512 MB**

**Cache Size 512 KB**

**Find the No. of Tag bits.**

MM Size = 512 MB = 2⁹ x 2²⁰ B = 2²⁹ B

Cache Size = 512 KB = 2⁹ x 2¹⁰ B = 2¹⁹ B

No. of Tag Bits: log₂(2²⁹ / 2¹⁹) = log₂⁽²⁹⁻¹⁹⁾ = log₂2¹⁰ = 10

1. **MM Size 4 GB**

**Block Size 2 KB**

**Comparator Delay = 20n nsec**

**Delay of multi-input OR gate = 4 nsec**

**Find the hit latency?**

Block Size = 2 KB = 2¹ \* 2¹⁰ B = 2¹¹ B

∴ No. of Block Offset bits = log₂(2¹¹) = 11

MM Size = 4 GB = 2² \* 2³⁰ B = 2⁽²⁺³⁰⁾ B = 2³² B

∴ No. of Physical Address bits = log₂(2³²) = 32

Number of Blocks in MM = MM Size / Block Size = 2⁽³²⁻¹¹⁾

∴ No. of Line Number bits = 32 - 11 = 21

No. of Tag bits = Physical Address bits - (Line Number bits + Block Offset bits)

= 32 - (21 + 11) = 0

Since there are no tag bits, the cache is direct-mapped, and there's no need for a comparator. Therefore, the hit latency is only the delay caused by accessing the cache:

Hit latency = Comparator Delay + Delay of multi-input OR gate

= 20 ns + 4 ns

= 24 ns

1. **MM Size = 4 GB**

**Cache size = 2 MB**

**Comparator Delay = 10n nsec**

**Find the Hit latency?**

MM Size = 2² x 2³⁰ B = 2³² B

Cache Size = 2 x 2²⁰ B = 2²⁰ B

Tag bits = log (2³² / 2²⁰) = log₂ 2¹² = 12

Hit latency = 10 x 12 = 120 nsec

1. **Byte-addressable MM Size = 32 GB**

**Block Size = 8 KB**

**No. of Tag Bits = 10**

**Find the Cache Size?**

MM Size = 2⁵ x 2³⁰ B = 2³⁵ B

P.A. Bits = log₂ 2³⁵ B = 35

Block Size = 2² x 2¹⁰ B = 2¹² B

Block Offset = log₂ 2¹⁴ = 14

Line number bits = 35 (10 + 14) = 11

Cache lines = 2¹¹

Cache size = 2¹¹ x 2¹⁴ B = 2²⁵ B

= 2⁵ x 2²⁰ B = 32 MB