

# Algorithm: Direct Mapped Cache Simulation

## Step 1: Start

1. Begin the program execution.

## Step 2: Define Cache Parameters

1. Set:

CACHE\_LINES = 8  
BLOCK\_SIZE = 4  
MAX\_ADDRESS = 65535 (16-bit address limit)

2. Declare arrays:

cache[CACHE\_LINES] to store block numbers  
tag[CACHE\_LINES] to store tag values  
valid[CACHE\_LINES] to store valid bits

## Step 3: Initialize Cache

1. Set all valid bits to zero:
2. valid[i] = 0 for all i = 0 to CACHE\_LINES – 1
3. Initialize:

hits = 0  
misses = 0

## Step 4: Display Menu (Loop)

1. Display the menu:  
Enter memory address  
Exit
2. Read the user's choice.

## Step 5: Exit Condition

1. If the user selects 2, terminate the loop and end the simulation.
2. If the choice is invalid, display an error message and return to the menu.

## Step 6: Read Memory Address

1. Prompt the user to enter a 16-bit memory address.
2. If the address is greater than MAX\_ADDRESS, display an error message and return to the menu.
- 3.

## Step 7: Address Mapping Calculations

1. Compute the Block Number:

$$\text{blockNumber} = \frac{\text{address}}{\text{BLOCK\_SIZE}}$$

2. Compute the Cache Line Index:

$$\text{index} = \text{blockNumber} \bmod \text{CACHE\_LINES}$$

3. Compute the **Tag Value**:

$$\text{tagValue} = \frac{\text{blockNumber}}{\text{CACHE\_LINES}}$$

4. Compute the **Offset**:

$$\text{offset} = \text{address} \bmod \text{BLOCK\_SIZE}$$

**Step 8: Cache Access (Hit or Miss Check)**

1. Check the valid bit of the calculated cache line:

If  $\text{valid}[\text{index}] == 1$  **and**  $\text{tag}[\text{index}] == \text{tagValue}$ :

    Declare **CACHE HIT**

    Increment hits

Else:

    Declare **CACHE MISS**

    Load the block into cache:

$\text{cache}[\text{index}] = \text{blockNumber}$

$\text{tag}[\text{index}] = \text{tagValue}$

$\text{valid}[\text{index}] = 1$

    Increment misses

**Step 9: Display Cache State**

1. Display the content of all cache lines:

    Show block number and tag if valid

    Show EMPTY if invalid

**Step 10: Display Statistics**

1. Display:

    Total number of hits

    Total number of misses

2. Calculate and display **Hit Ratio**:

$$\text{Hit Ratio} = \frac{\text{hits}}{\text{hits} + \text{misses}}$$

**Step 11: Repeat**

1. Return to **Step 4** to process the next address.

**Step 12: End**

1. Display "Simulation Ended."

2. Stop the program.