

# 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**:  
$$blockNumber = \frac{address}{BLOCK\_SIZE}$$
2. Compute the **Cache Line Index**:  
$$index = blockNumber \bmod CACHE\_LINES$$

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.