

(a) 000001000100000101 (read access)

->000001 000100000101

Page number is 1, which is mapped to frame 0 in the physical memory.

TLB HIT

Physical address=0000 000100000101

Page Table

| virtual page | frame | valid | dirty | read-only | reference |
|--------------|-------|-------|-------|-----------|-----------|
| 0            | 2     | 1     | 0     | 1         | 0         |
| 1            | 0     | 1     | 0     | 0         | 1         |
| 2            | 1     | 1     | 0     | 1         | 1         |
| 3            | 5     | 1     | 0     | 0         | 1         |
| 4            | 3     | 1     | 0     | 0         | 0         |

TLB

virtual page frame valid dirty read-only reference

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 2 | 1 | 1 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 |

(b) 0000000000011000100 (write access) ->

000000 000011000100

Page number is 0, which is mapped to frame 2 in the physical memory.

TLB HIT

Physical address=0010 000011000100

Since it is read only, we can't write it.

| Page Table   |       |       |       |           |                |
|--------------|-------|-------|-------|-----------|----------------|
| virtual page | frame | valid | dirty | read-only | reference      |
| 0            | 2     | 1     | 0     | 1         | <del>0</del> 1 |
| 1            | 0     | 1     | 0     | 0         | 1              |
| 2            | 1     | 1     | 0     | 1         | 1              |
| 3            | 5     | 1     | 0     | 0         | 1              |
| 4            | 3     | 1     | 0     | 0         | 0              |

  

| TLB          |       |       |       |           |           |
|--------------|-------|-------|-------|-----------|-----------|
| virtual page | frame | valid | dirty | read-only | reference |
| 2            | 1     | 1     | 0     | 1         | 1         |
| 1            | 0     | 1     | 0     | 0         | 1         |

(c) 000011000101100100 (write access)

-> 000011 000101100100

Page number is 3, which is mapped to frame 5 in the physical memory.

Physical address=0101 000101100100

TLB miss

| Page Table   |       |       |                |           |                |
|--------------|-------|-------|----------------|-----------|----------------|
| virtual page | frame | valid | dirty          | read-only | reference      |
| 0            | 2     | 1     | 0              | 1         | <del>0</del> 1 |
| 1            | 0     | 1     | 0              | 0         | 1              |
| 2            | 1     | 1     | 0              | 1         | 1              |
| 3            | 5     | 1     | <del>0</del> 1 | 0         | 1              |
| 4            | 3     | 1     | 0              | 0         | 0              |

  

| TLB            |                |       |                |                |           |
|----------------|----------------|-------|----------------|----------------|-----------|
| virtual page   | frame          | valid | dirty          | read-only      | reference |
| <del>2</del> 3 | <del>1</del> 5 | 1     | <del>0</del> 1 | <del>1</del> 0 | 1         |
| 1              | 0              | 1     | 0              | 0              | 1         |

(d) 000010000101010100 (read access)

-> 000010 000101010100

Page number is 2, which is mapped to frame 1 in the physical memory.

Physical address=0001 000101010100

TLB miss

| Page Table   |       |       |                |           |                |
|--------------|-------|-------|----------------|-----------|----------------|
| virtual page | frame | valid | dirty          | read-only | reference      |
| 0            | 2     | 1     | 0              | 1         | <del>0</del> 1 |
| 1            | 0     | 1     | 0              | 0         | 1              |
| 2            | 1     | 1     | 0              | 1         | 1              |
| 3            | 5     | 1     | <del>0</del> 1 | 0         | 1              |
| 4            | 3     | 1     | 0              | 0         | 0              |

  

| TLB            |                |       |                |                |           |
|----------------|----------------|-------|----------------|----------------|-----------|
| virtual page   | frame          | valid | dirty          | read-only      | reference |
| <del>2</del> 3 | <del>5</del> 1 | 1     | <del>0</del> 1 | <del>1</del> 0 | 1         |
| <del>1</del> 2 | <del>0</del> 1 | 1     | 0              | <del>0</del> 1 | 1         |