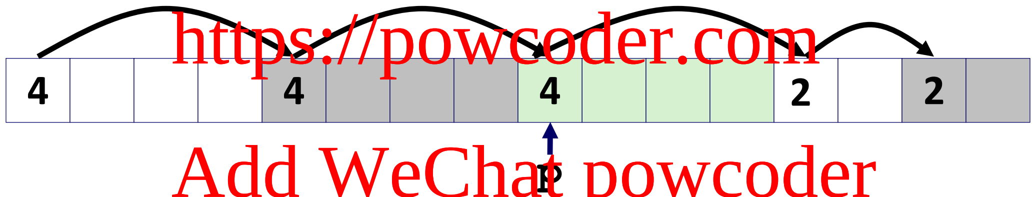
Implicit List: Freeing a Block

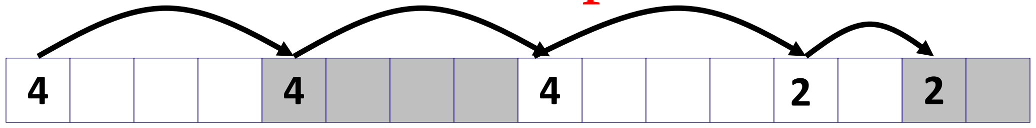
- **Simplest implementation:**
  - Need only clear the “allocated” flag

```
void free_block(ptr p) { *p = *p & -2 }
```

  - But can lead to “false fragmentation”



`free(p)`

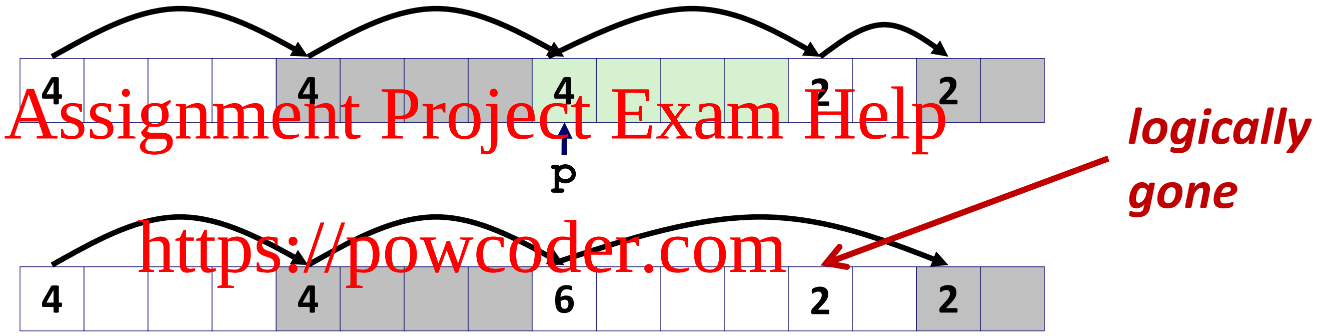


`malloc(5)` ***Oops!***

There is enough free space, but the allocator won’t be able to find it

Implicit List: Coalescing

- **Join *(coalesce)* with next/previous blocks, if they are free**
  - Coalescing with next block

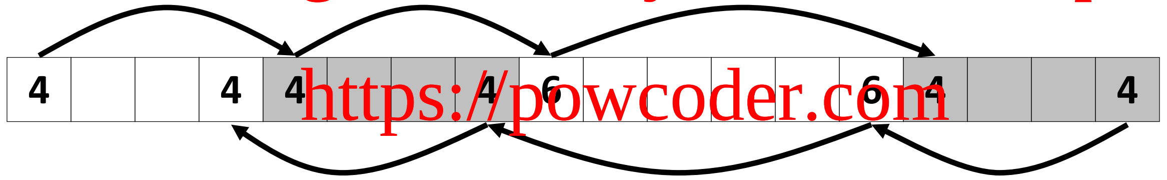


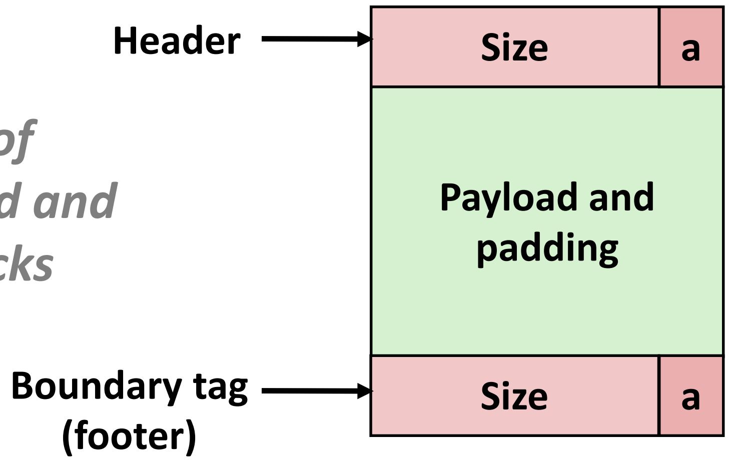
```
void free_block(ptr p) {
    *p = *p & -2;           // clear allocated flag
    next = p + *p;          // find next block
    if ((*next & 1) == 0)
      *p = *p + *next;      // add to this block if
}                           //    not allocated
```

  - But how do we coalesce with *previous* block?

Implicit List: Bidirectional Coalescing

- ***Boundary tags*** [Knuth73]
  - Replicate size/allocated word at "bottom" (end) of free blocks
  - Allows us to traverse the "list" backwards, but requires extra space
  - Important and general technique!





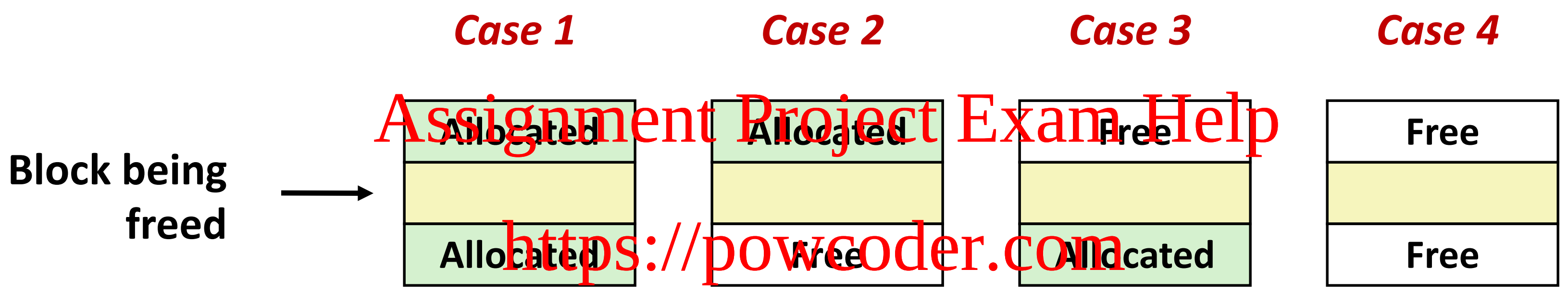
Format of allocated and free blocks

a = 1: Allocated block
a = 0: Free block

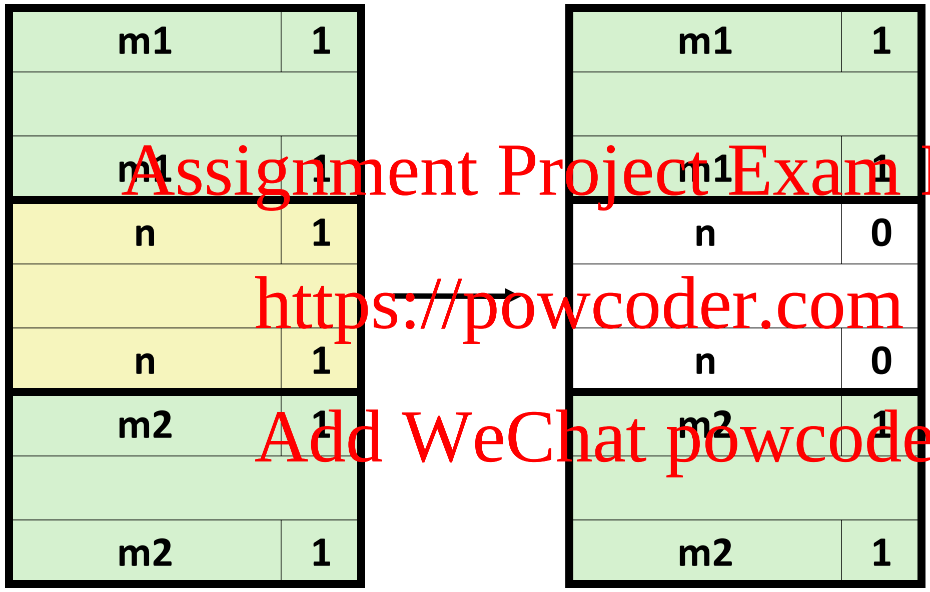
Size: Total block size

Payload: Application data (allocated blocks only)

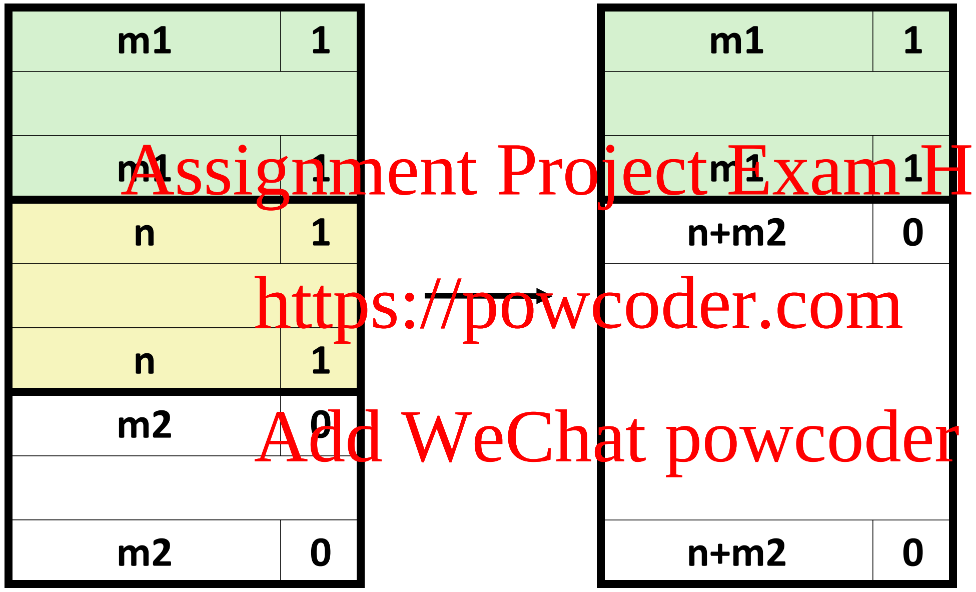
Constant Time Coalescing



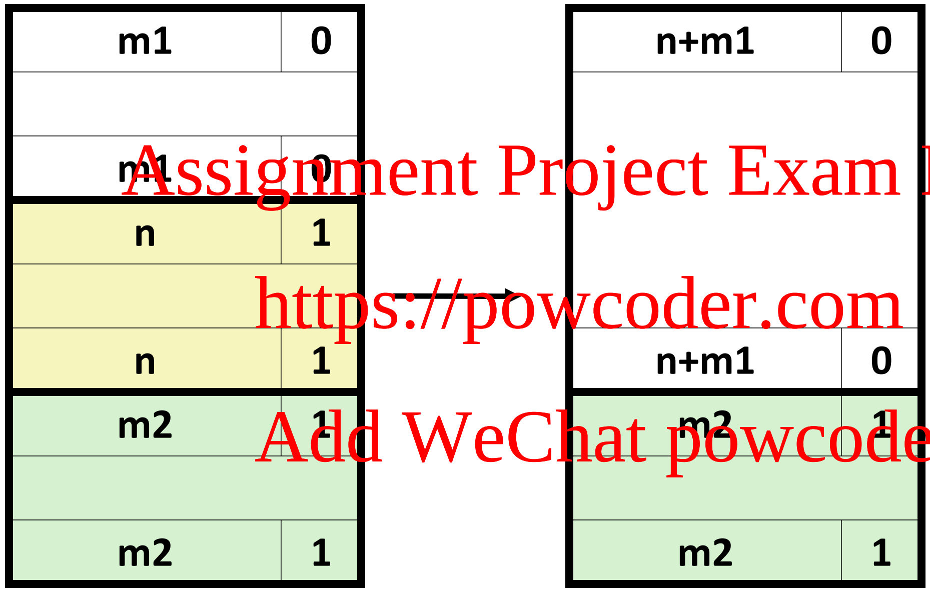
Constant Time Coalescing (Case 1)



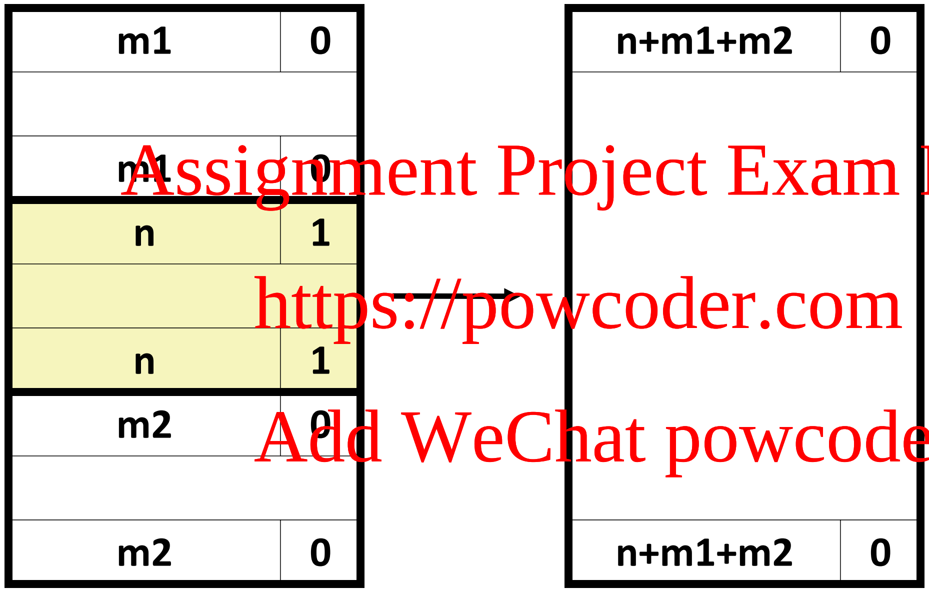
Constant Time Coalescing (Case 2)



Constant Time Coalescing (Case 3)



Constant Time Coalescing (Case 4)


m1
0
m1
0
n
1
n
1
m2
0
m2
0
n+m1+m2
0
n+m1+m2
0