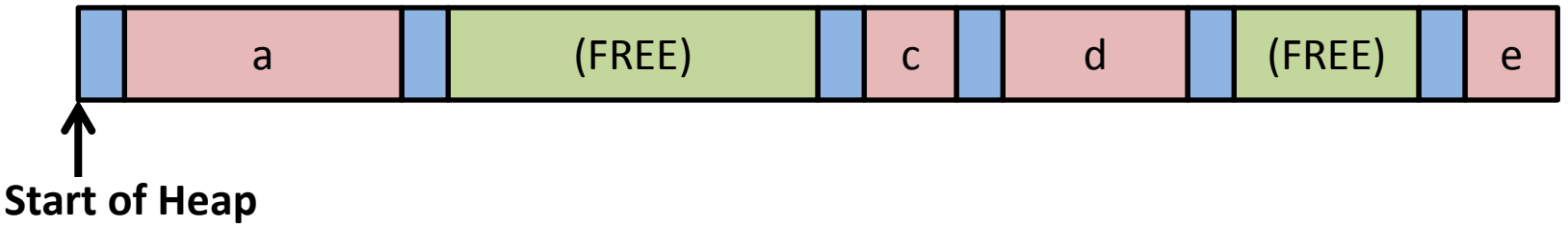
Heap Memory, Part 2
Optimizations and Buddy System

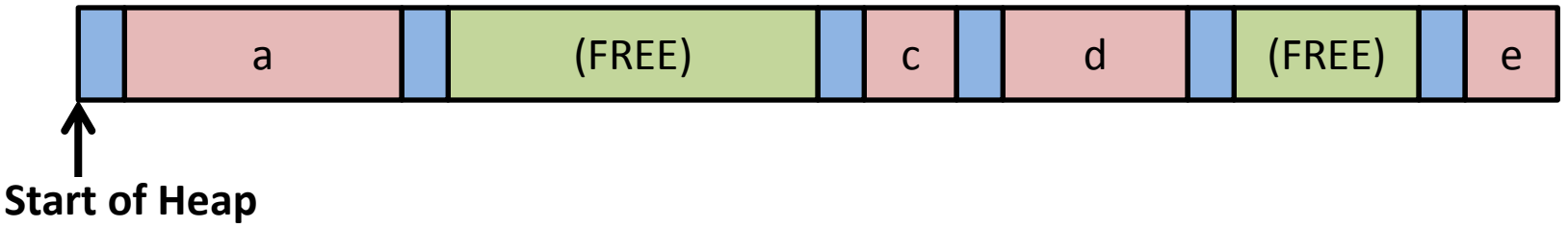
CS 241

Sept. 11, 2013

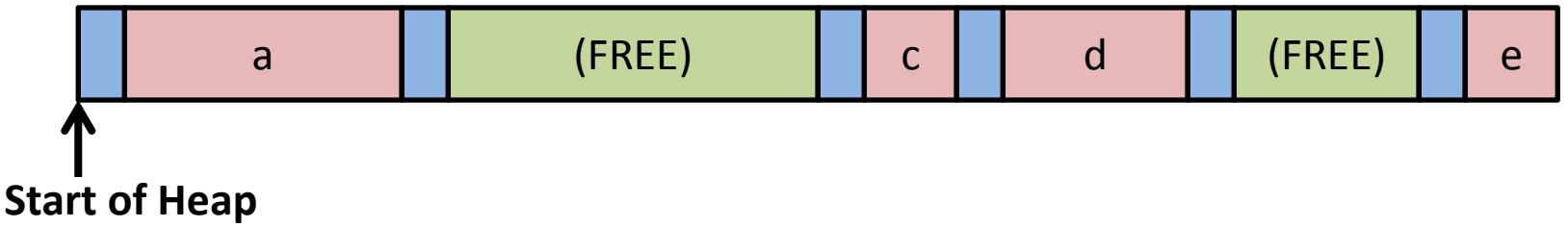
Metadata Optimizations



Metadata Optimizations



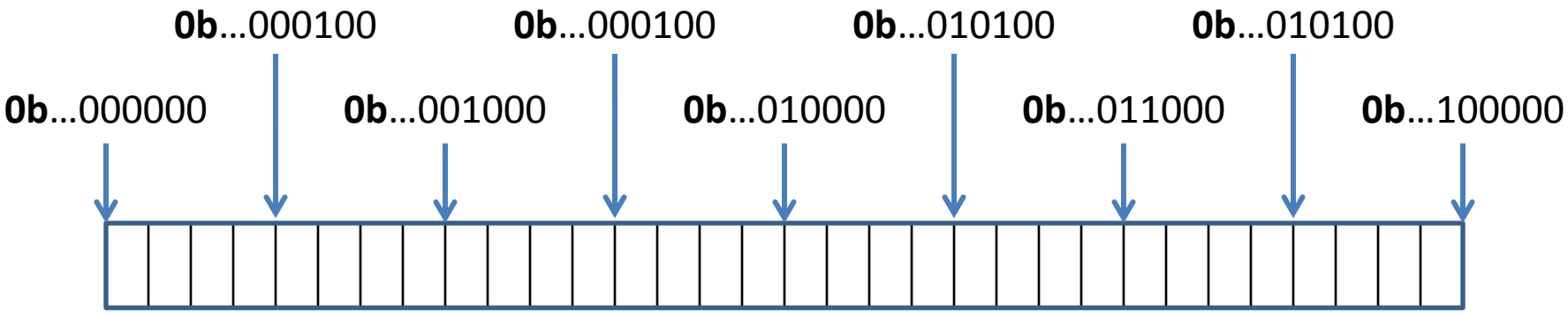
Metadata Optimizations



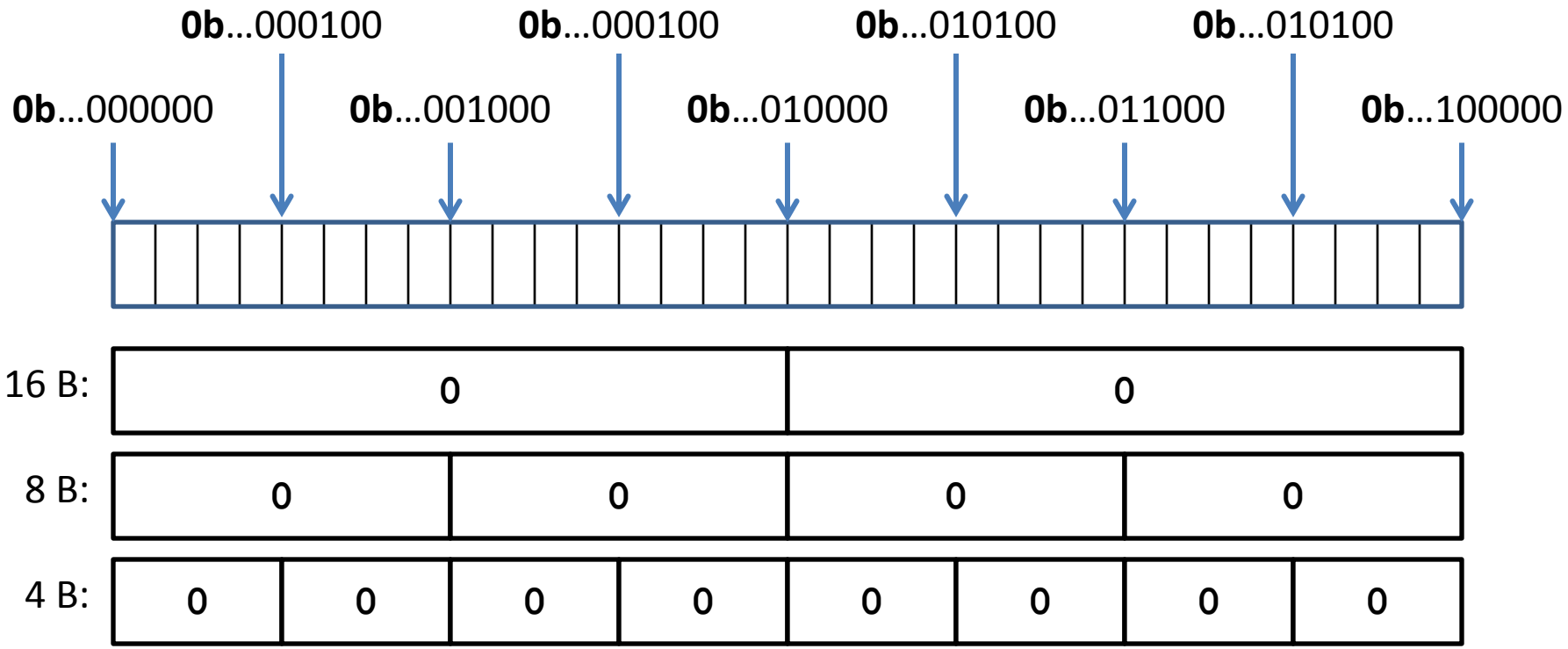
Strategy #3: Buddy System

- The buddy system consists of segments of memory where each segment has a “buddy”.
  - Each segments is always 2^n bytes
  - The buddy for a segment is flipping the n-th bit:
    - **0b**00001000 ⇔ **0b**00000000
  - A bitmap is maintained for each level of allocation to determine if the segment is free or used.
    - 32 B allocation bitmap
    - 16 B allocation bitmap
    - 8 B allocation bitmap
    - …

Strategy #3: Buddy System

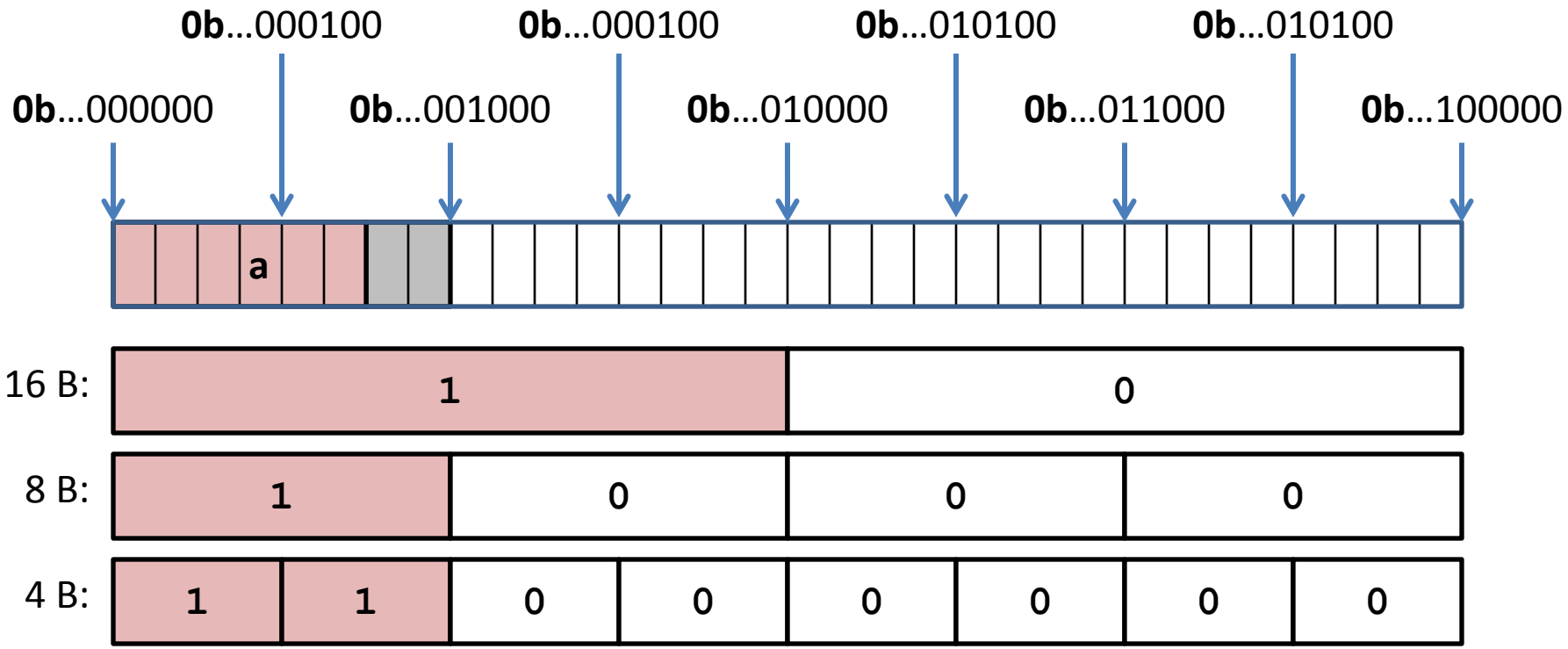


Strategy #3: Buddy System



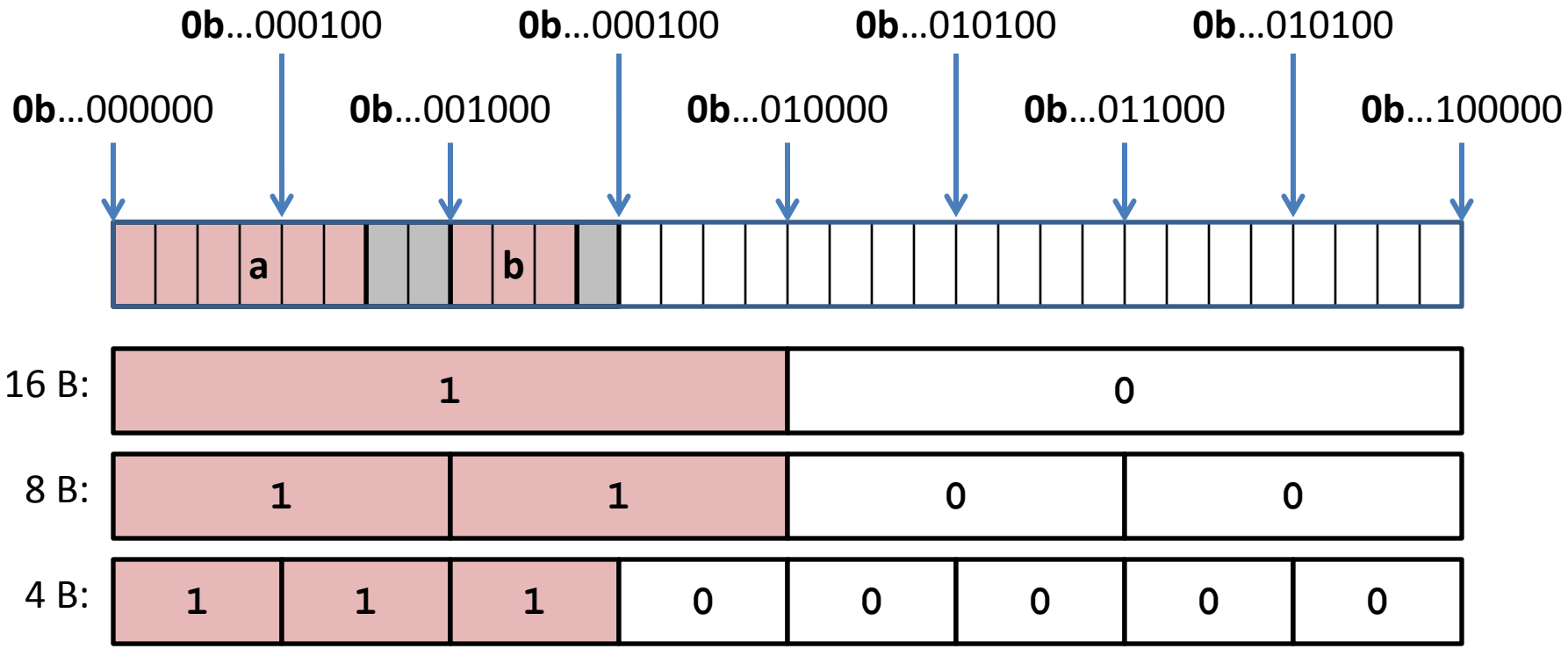

```
void *a = malloc( 6 );
```

Strategy #3: Buddy System



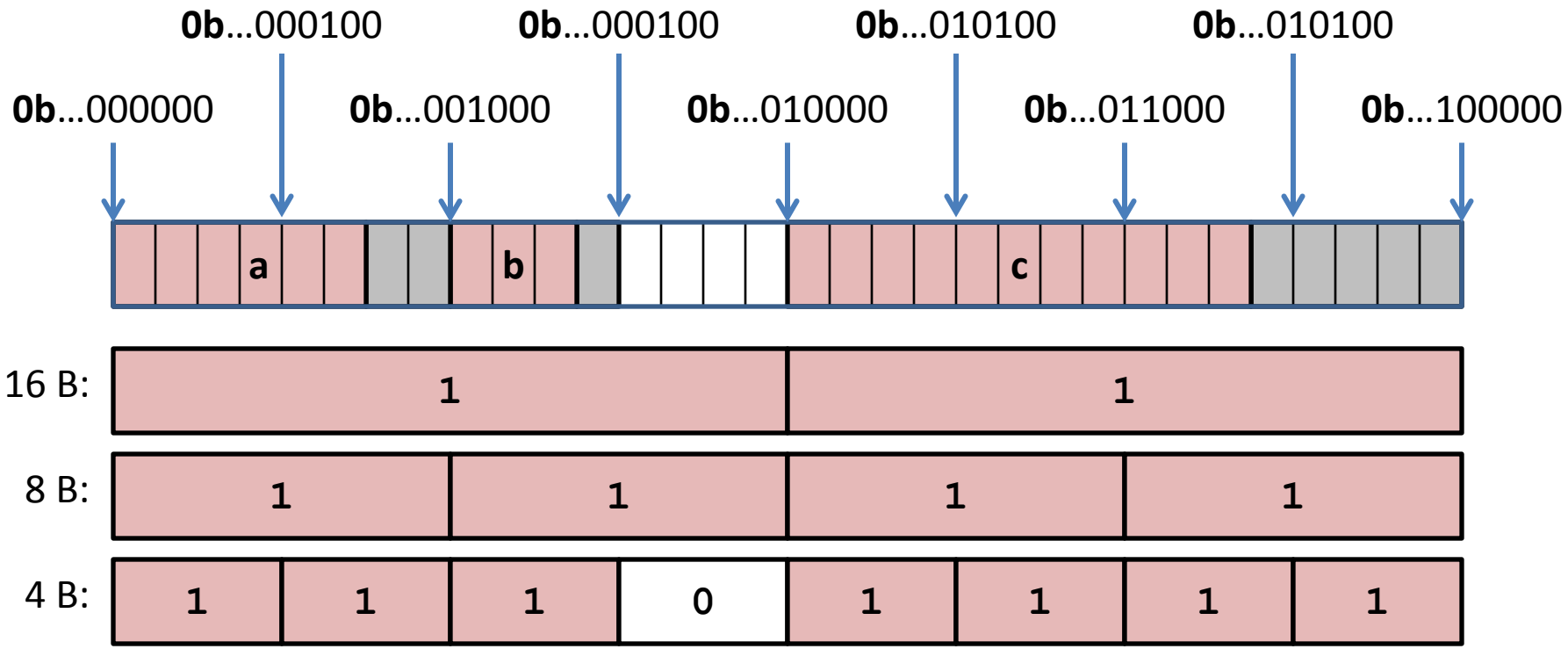

```
void *b = malloc( 3 );
```

Strategy #3: Buddy System



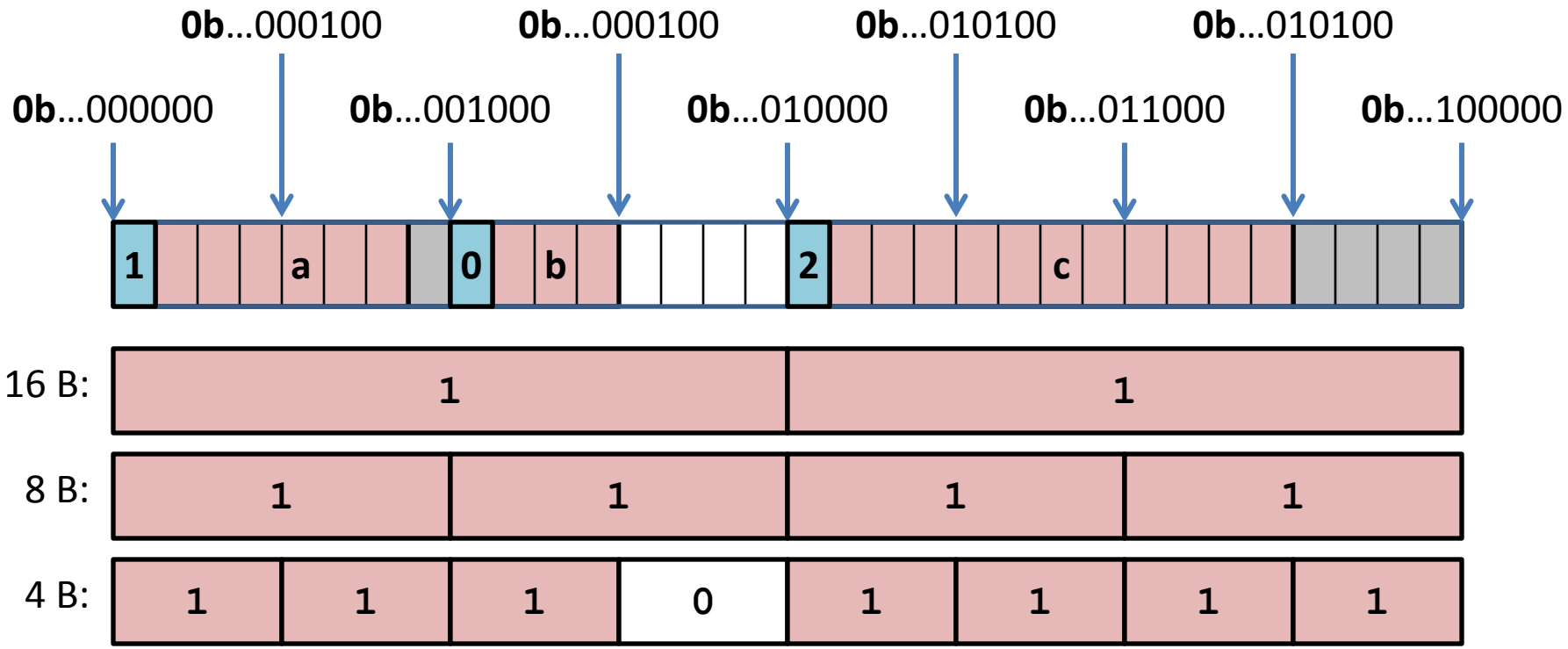

```
void *c = malloc( 11 );
```

Strategy #3: Buddy System




```
free(b == 0b...001000)
```

Strategy #3: Buddy System




```
free(b == 0b...001000)
```

Strategy Comparison

- **Overhead**:
  - Dictionary:
  - Metadata:
  - Buddy System:

- **Unusable Space** (“Internal Fragmentation”):
  - Dictionary:
  - Metadata:
  - Buddy System:

Strategy Comparison

- **Find a "best fit" on malloc()**:
  - Dictionary:
  - Metadata:
  - Buddy System:

- **Find `p` in data structure on `free(p)`** :
  - Dictionary:
  - Metadata:
  - Buddy System:

MP2