Memory management

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C program

```
#include <stdlib.h>

int global = 42;

int main(int argc, char *argv[]) {

  if(argc < 2) return -1;

  int n = atoi(argv[1]);

  int on_stack[5] = {1,2,3,4,5};

  int *on_heap = malloc(sizeof(int)*n);

    :

}
```

The POSIX API

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The free() function frees the memory space pointed to by ptr, which must have been returned by a previous call to malloc(), ..

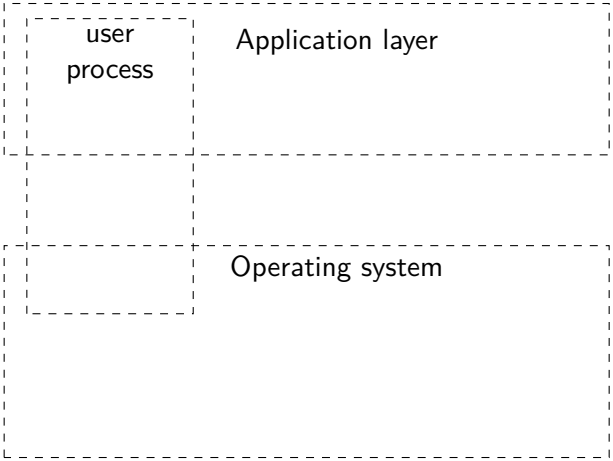
:

The operating system

Application layer

Operating system

The operating system



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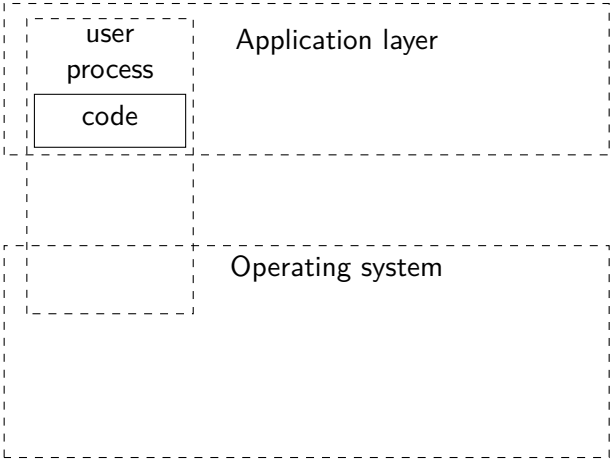

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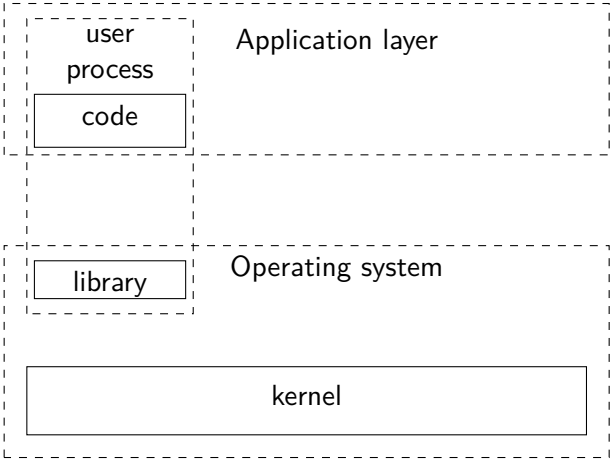

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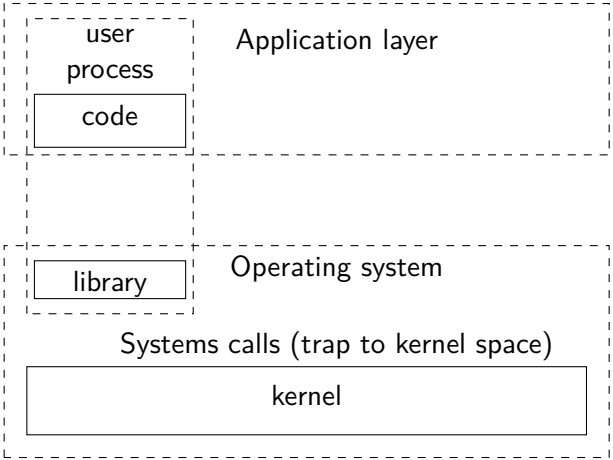

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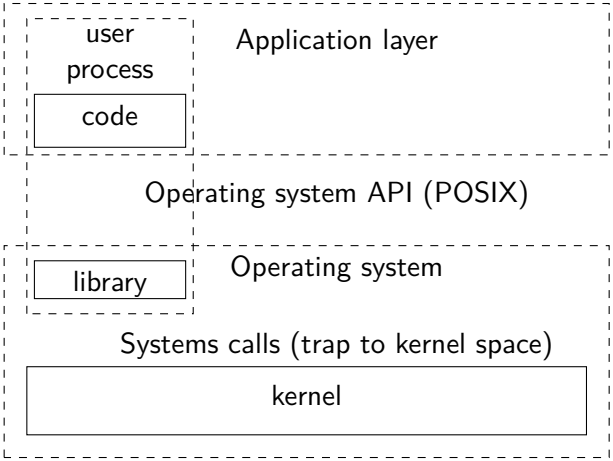

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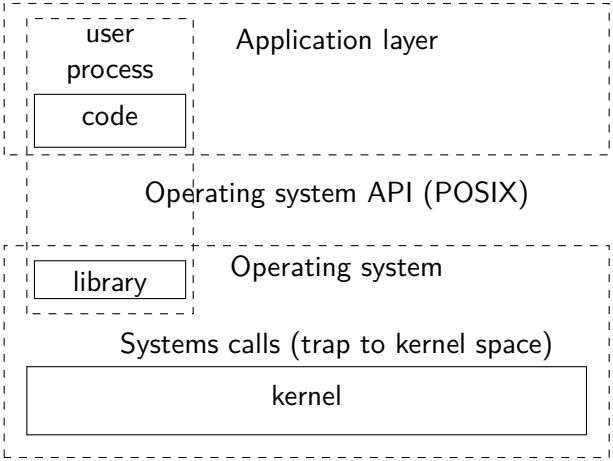

Library is often just a wrapper for the system call - sometimes more complex.

Linux system call

brk() and sbrk() change the location of the program break, which defines the end of the process's data segment

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Calling sbrk() with an increment of 0 can be used to find the current location of the program break.

User space program

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Library routines

malloc() / free()

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Kernel space

sbrk()

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`char a[10]`

`structs person {int age; char name[20]}`

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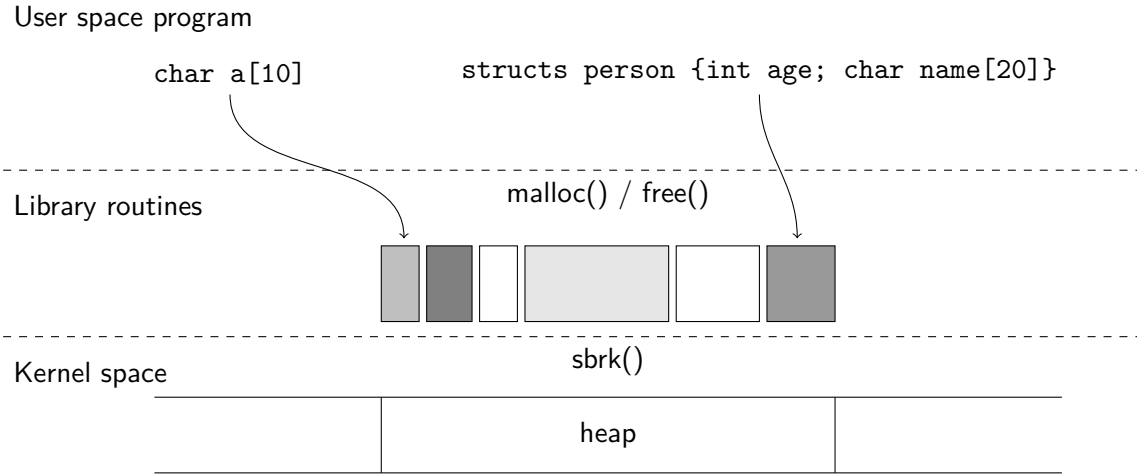
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Assume each free block holds a header containing: the size and a pointer to the next block.

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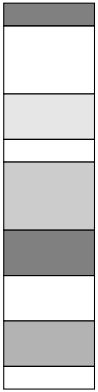

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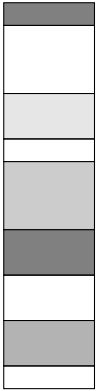

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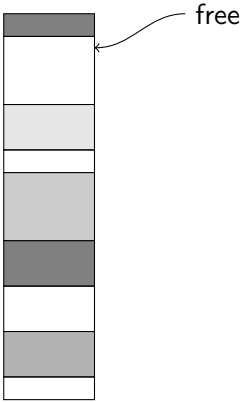

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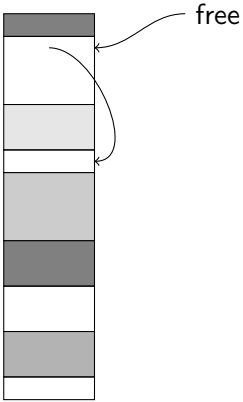

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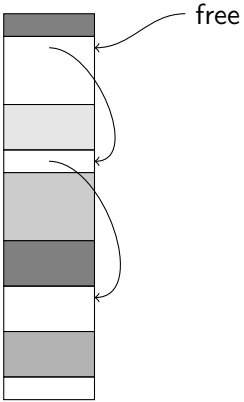

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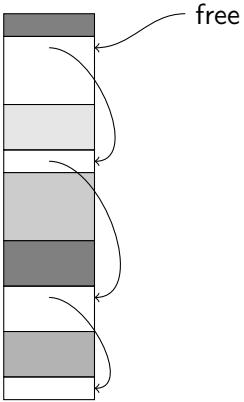

return a block

How do we return a block?

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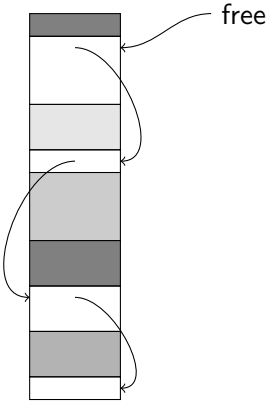

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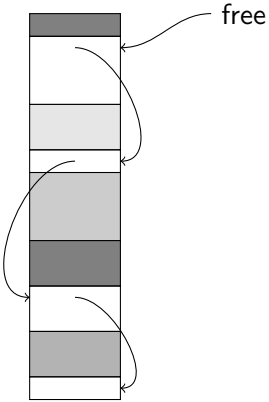

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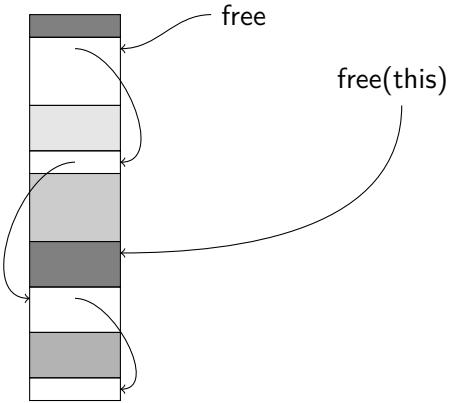

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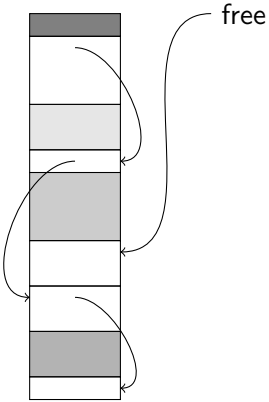

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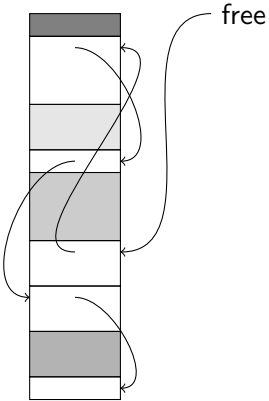

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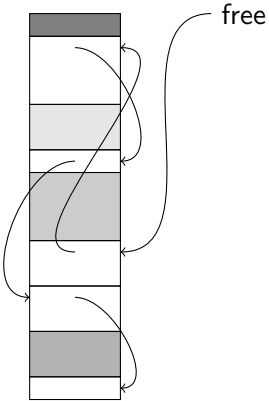

What's the problem?

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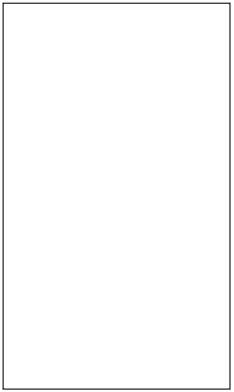

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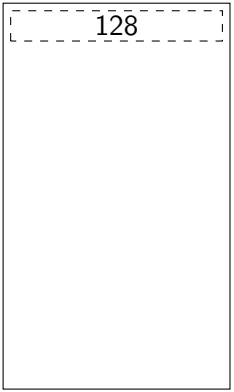

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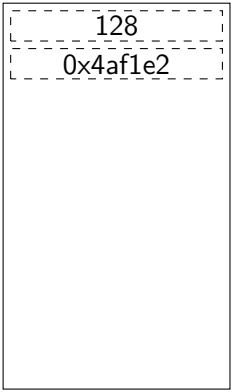

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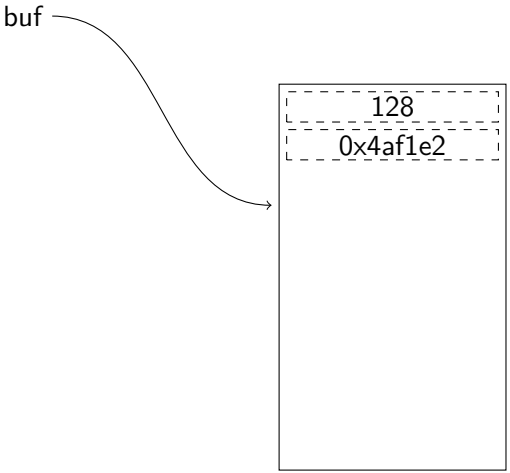

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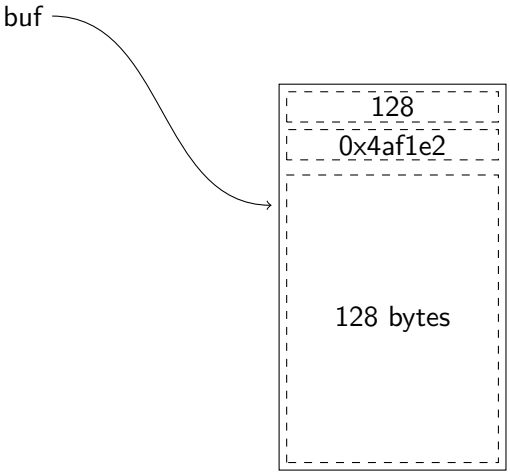
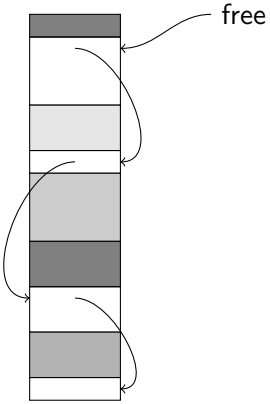


Coalescing - merging free blocks

When we return a block we need to merge it with adjacent free blocks - if any.



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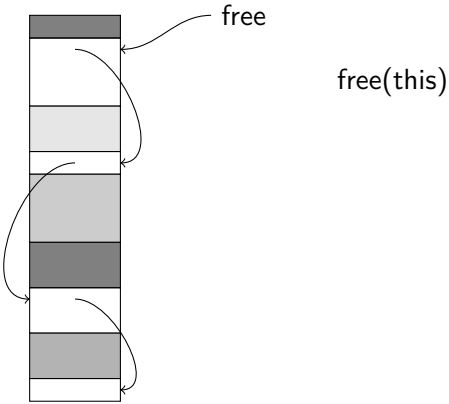

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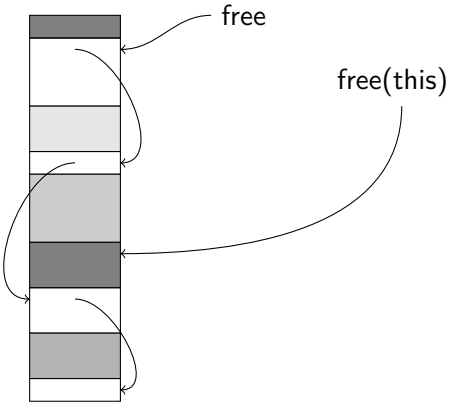

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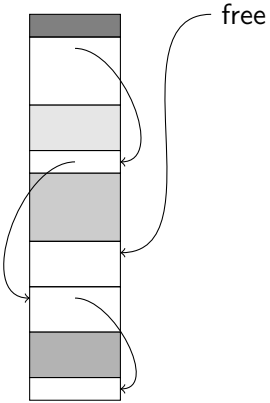

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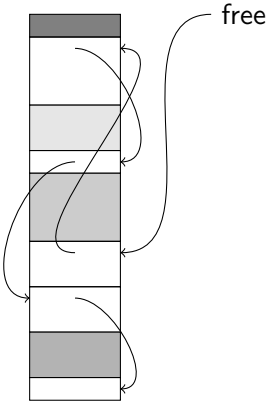

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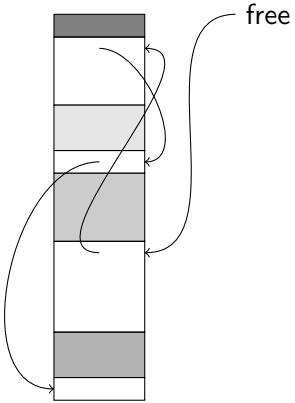
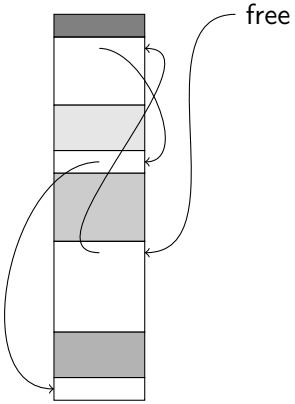


Malloc - find a suitable block and split it.



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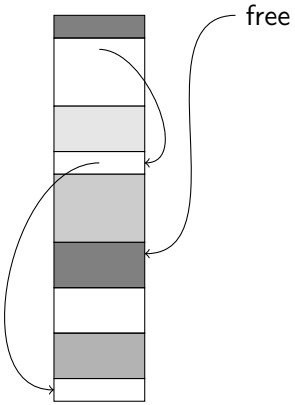

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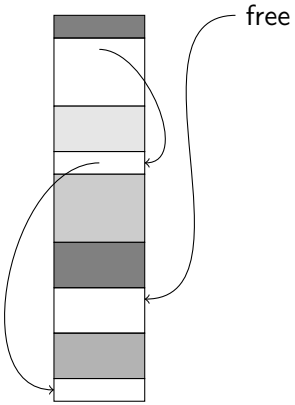

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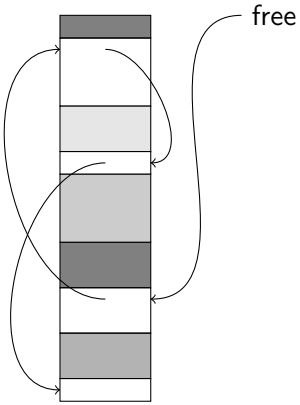

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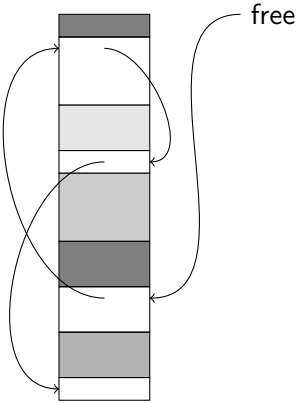
Which block shall we pick?



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You should know the pros and cons of these strategies.

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- What sizes should we choose, what needs to be considered?

We can build our own allocator that is optimized for a given application.

malloc in GNU/Linux

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Will coalesce adjacent chunks.

Buddy Allocation

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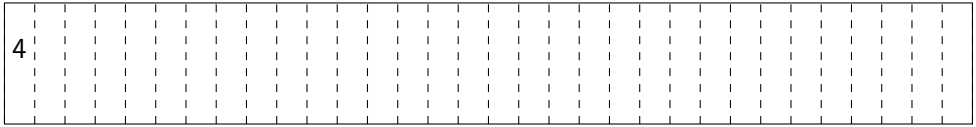
Assume total memory 128Kibyte, smallest allocated *frame* 4Kibyte



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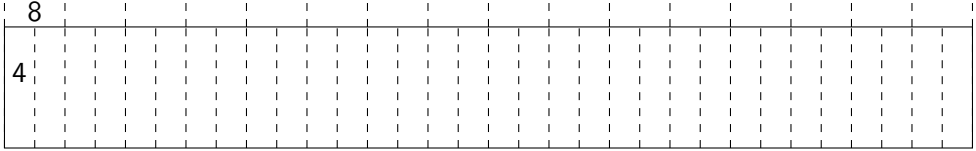

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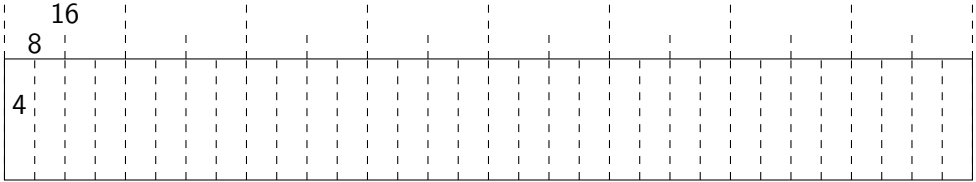

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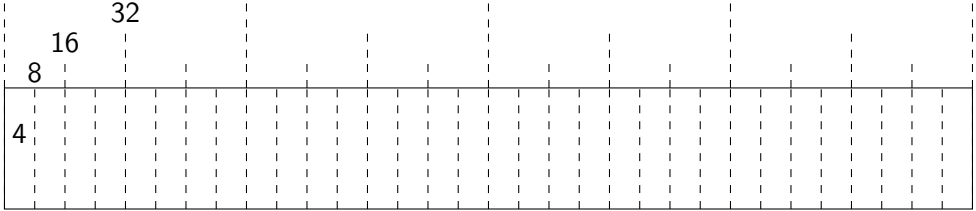

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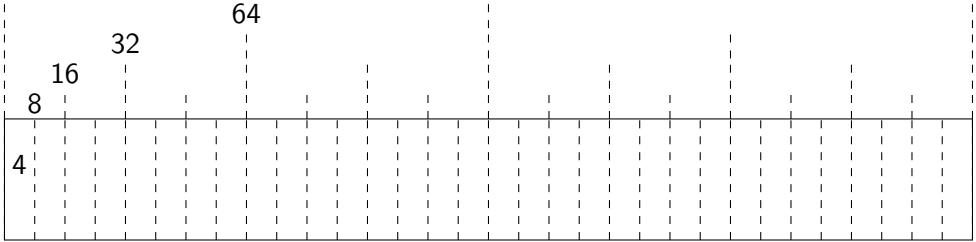

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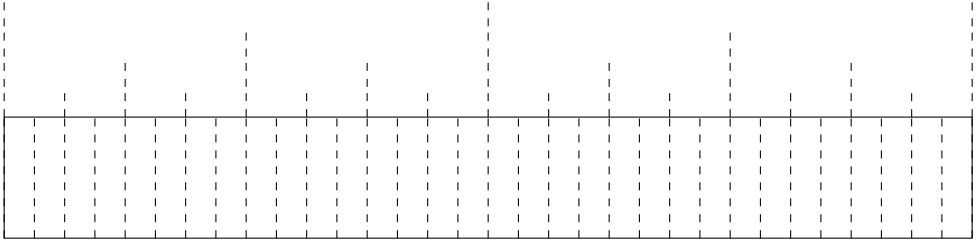

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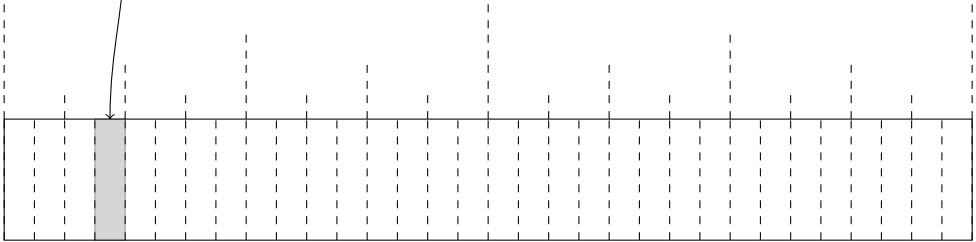

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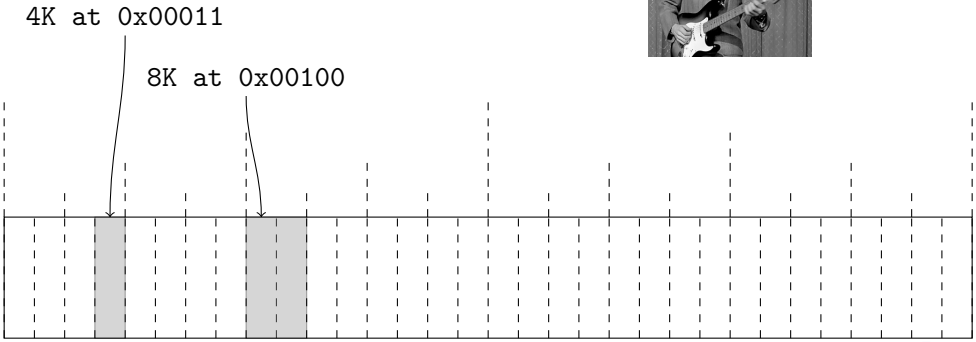

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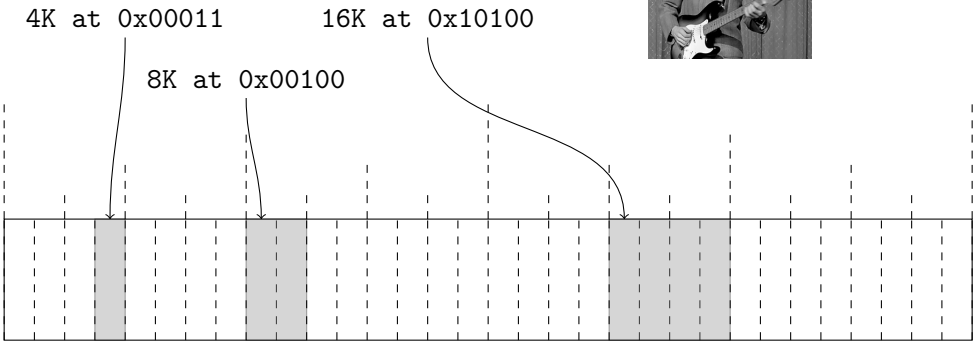

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Linux uses Buddy allocations when managing physical memory - check `/proc/buddyinfo`.

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Originally from 4.2BSD, default in OSX where mallc() uses mmap() to allocate memory.

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