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Memory Allocators

Section 1

Introduction

Applicable for

LINUX AND C

The Need for Memory Allocators

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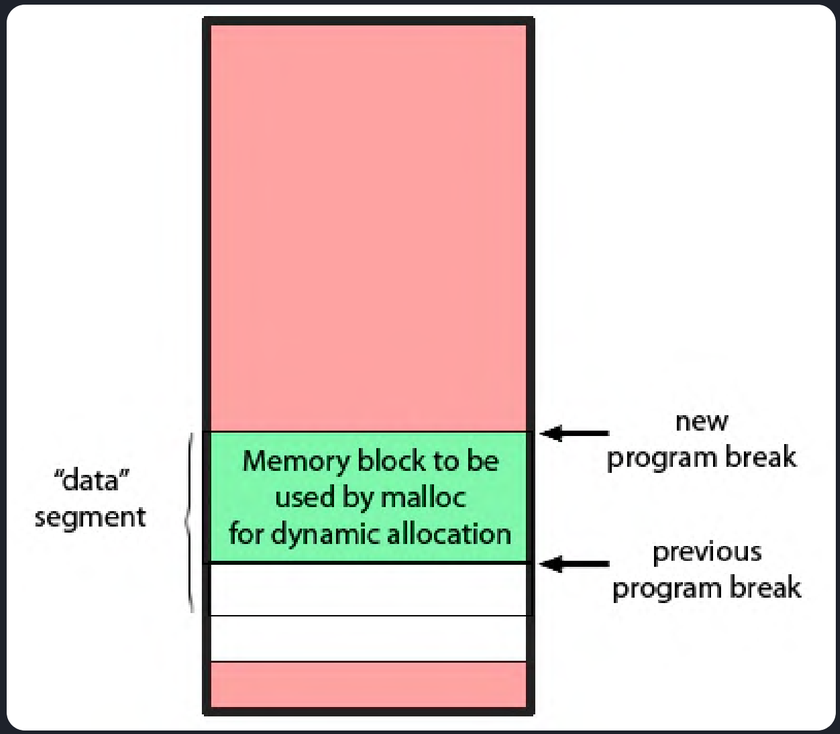

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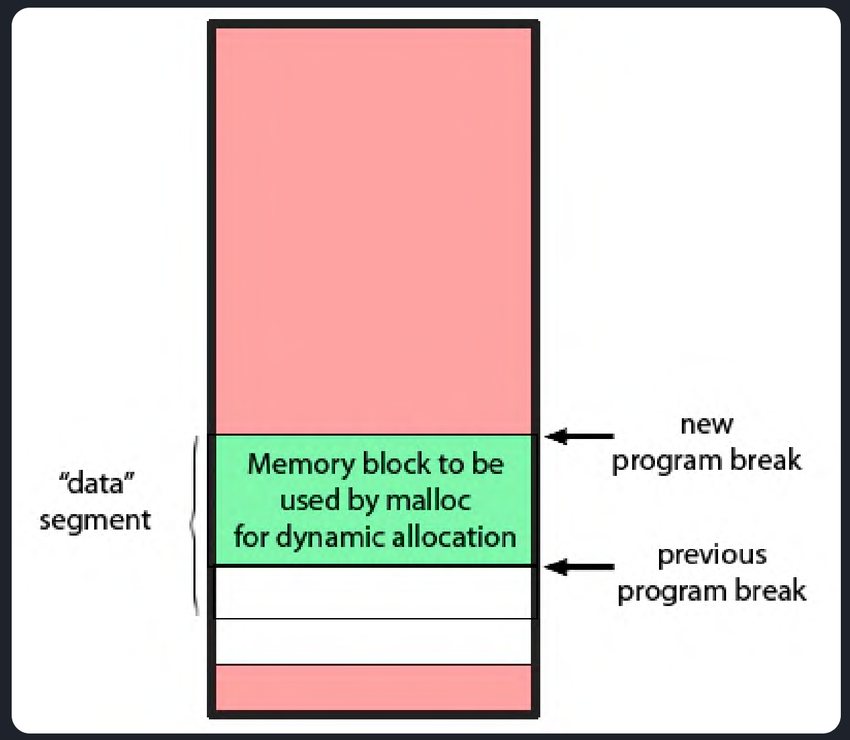


```c
void *malloc(size_t size)
{
        void *block;
        block = sbrk(size);
        if (block == (void*) -1)
                return NULL;
        return block;
}
```

The Need for Memory Allocators

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- **syscalls overhead** - syscalls requires switching from user mode to kernel mode which has its own overhead. Allocating small sized memory using these functions can be inefficient.
- **fragmentation** - The memory allocated may be fragmented. These heap based memory allocation do not give any way to use the fragmented memory and is thus wasted.
- **Copy on write (COW)** - Unix based operating systems generally employ copy-on-write mechanism for virtual memory management, specially in cases like fork(). So it may be possible that the memory requested has been marked as *not present* and accessing that memory can cause page fault issues.

Possible quick explanation example and explanation CoW if people want it at the end.

Dynamic Storage Allocation: A Survey and Critical Review * **

Paul R. Wilson, Mark S. Johnstone, Michael Neely, and David Boles***

Department of Computer Sciences
University of Texas at Austin
Austin, Texas, 78751, USA
(wilson|markj|neely@cs.utexas.edu)

Abstract. Dynamic memory allocation has been a fundamental part of most com-

1 Introduction

Paul Wilson and his colleagues have written an excellent survey paper on allocation techniques that discusses some of the goals in more detail - "Dynamic Storage Allocation: A Survey and Critical Review" in *International Workshop on Memory Management*, September 1995.

Conclusion : They discuss, minimizing space by minimizing wastage (generally due to fragmentation) must be the primary goal in any allocator.

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Implementations

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dlmalloc

A MEMORY ALLOCATOR BY ***DOUG LEA***

dlmalloc - Algorithms

Even though the program has been revised and improved over the years, but 2 core algorithms are still present.

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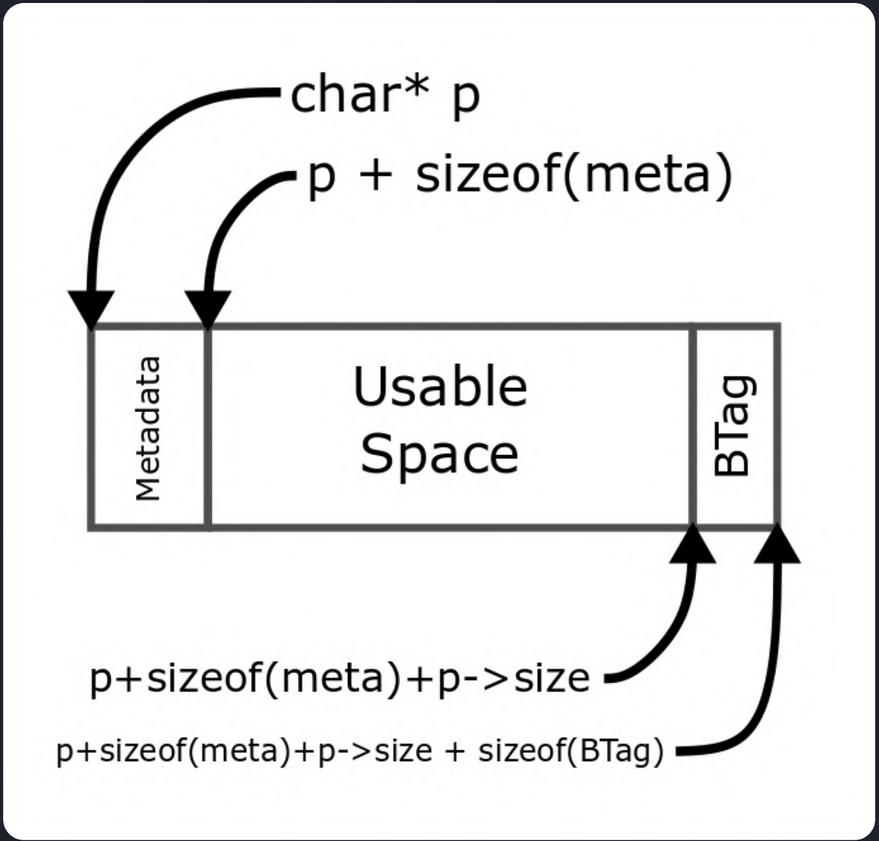

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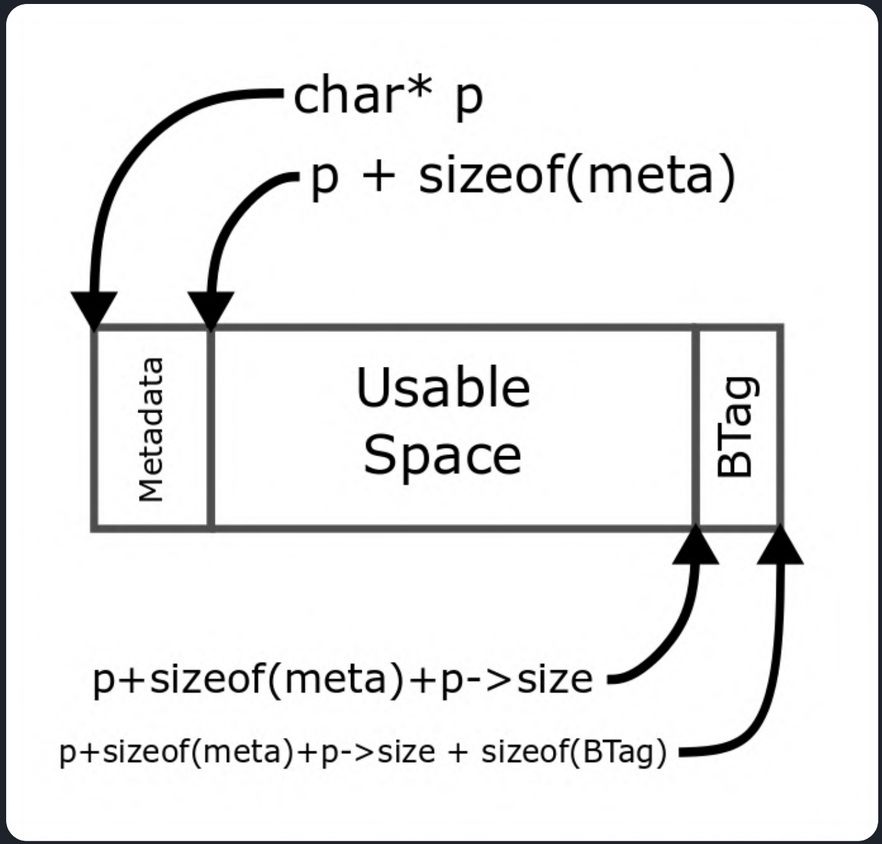

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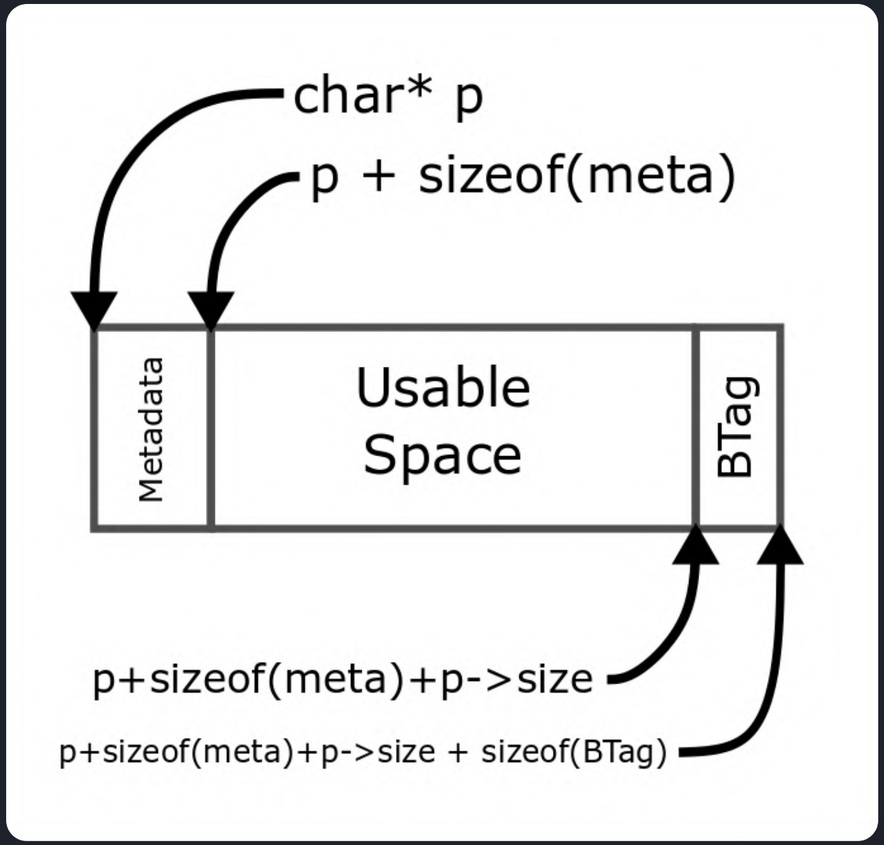

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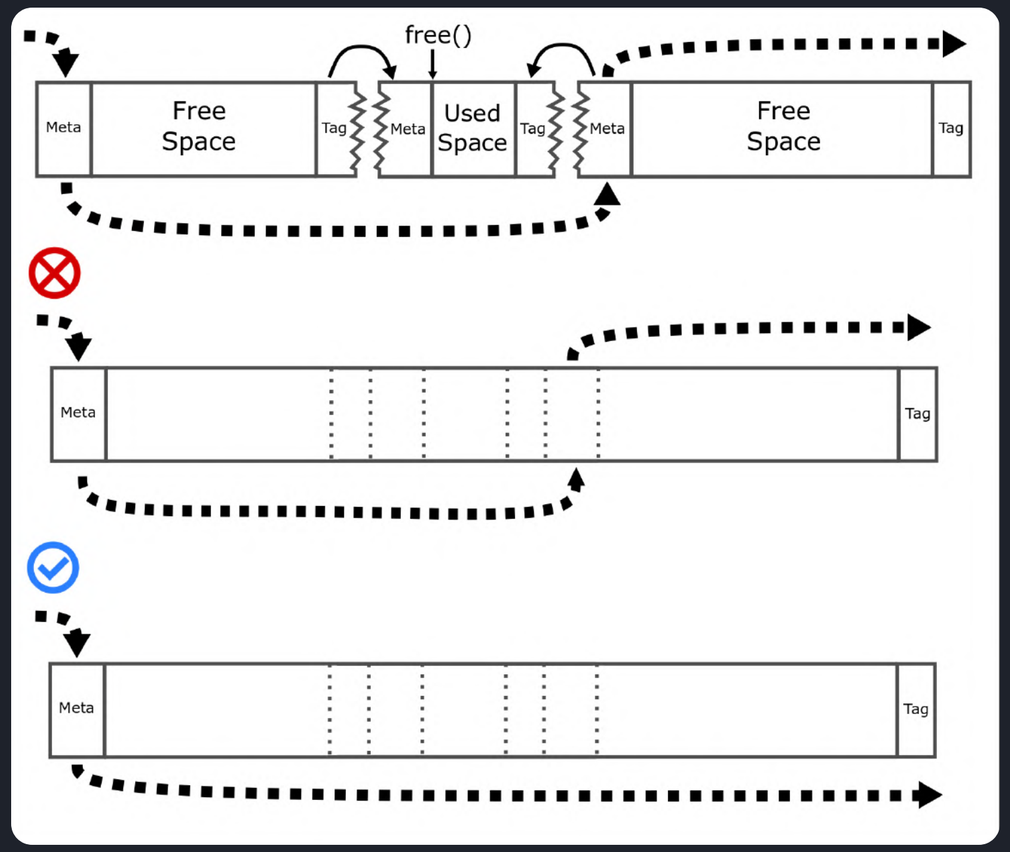

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This allows for two important capabilities:

- Two bordering unused chunks can be coalesced into one larger chunk. This minimizes the number of unusable small chunks.
- All chunks can be traversed starting from any known chunk in either a forward or backward direction.

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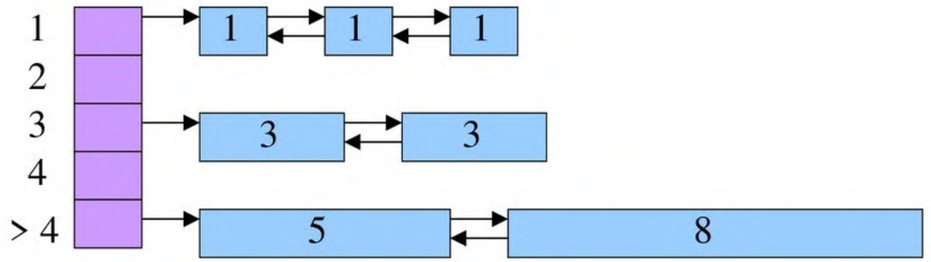
Even though the program has been revised and improved over the years, but 2 core algorithms are still present.

- Have a bin for each block size, up to a limit
  - Advantages: no search for requests up to that size
  - Disadvantages: many bins, each storing a pointer
- Except for a final bin for all larger free blocks
  - For allocating larger amounts of memory
  - For splitting to create smaller blocks, when needed



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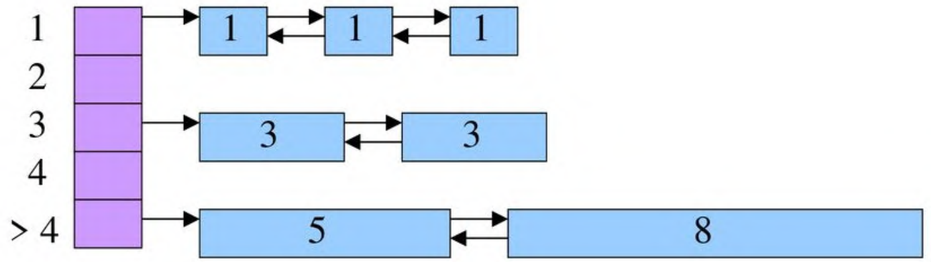

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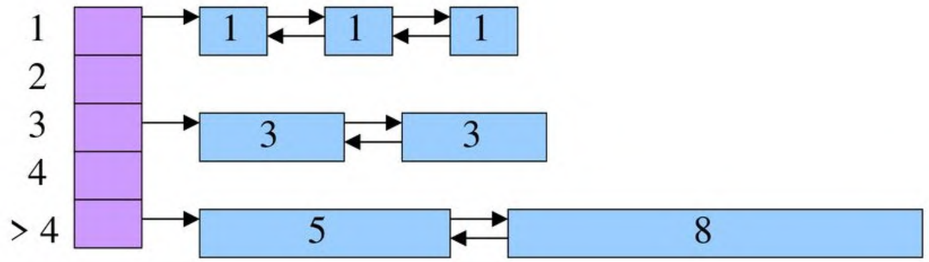

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Best fit strategy (searching if the required size block exists in the bin else breaking a large block into that size) is used to allocate memory for new allocation requests.

dlmalloc

These two algorithms are used to allocate and free memory blocks in `malloc()`.

SOURCE BLOG: http://gee.cs.oswego.edu/dl/html/malloc.html

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A big disadvantage : dlmalloc works only for single threaded programs. It fails for multi-threaded programs.

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ptmalloc

THE GLIBC IMPLEMENTATION

ptmalloc

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IMPLEMENTATION DETAILS : https://sourceware.org/glibc/wiki/MallocInternals

SOURCE CODE : https://github.com/hustfisher/ptmalloc

THANK YOU - PRESENTATION BY

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