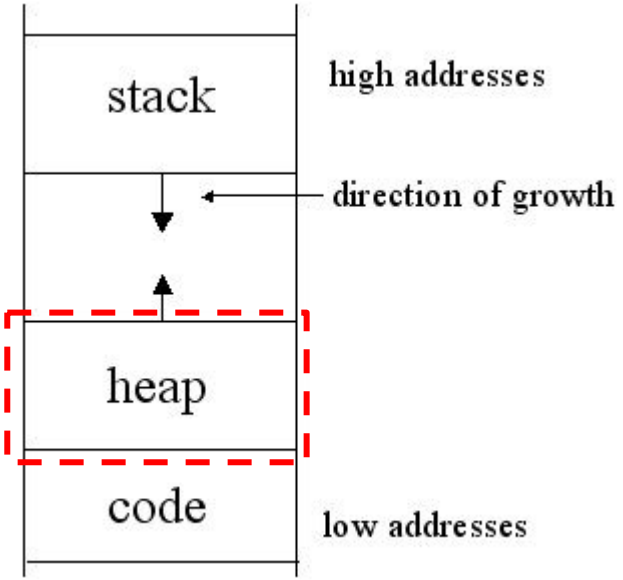
Dynamic memory (C/C++)

Mariano Trebino

Memory

- Code
  - Const data
  - Static and global variables
- Stack (LIFO)
  - Thread execution data
  - Variables
  - Stack pointer → **Simple!**
- Heap
  - Dynamic memory
  - Undefined behavior → **Complex**



Work with dynamic memory

- Explicit allocation
  - Allocate (or new)
  - Free (or delete/destroy) → memory leaks
- Implicit allocation
  - Allocate
  - “Never free” → Garbage Collector

Allocation of dynamic memory

Data type	Size (bytes)
Char	1
Short	2
Int	4
Double	8
Object	?

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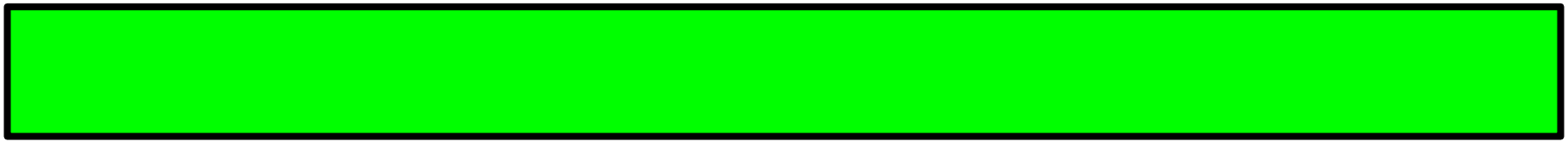
0



C,C,C,S,I,C,D,D,I

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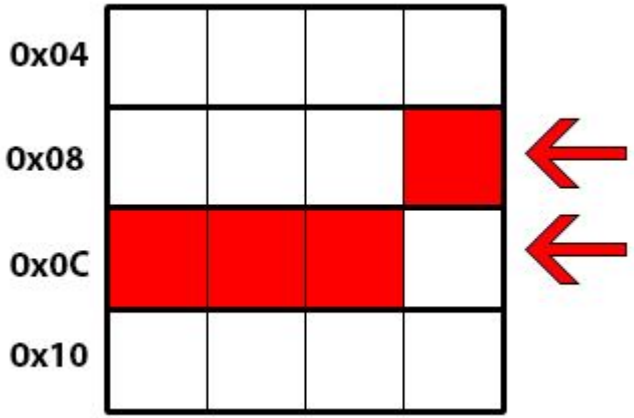
I,C,D,D,I

Alignment

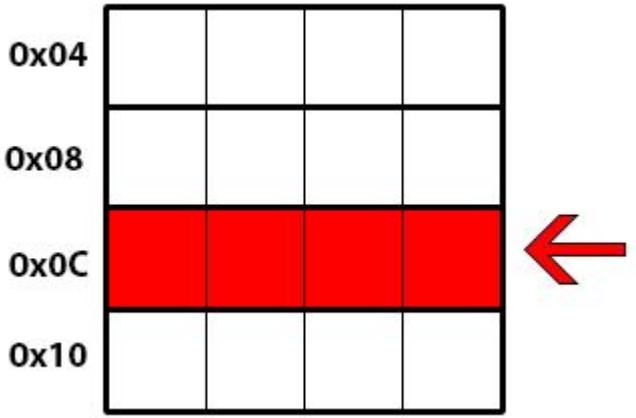
- The address of the data must be a multiple of its alignment
- For primitives types the alignment is equal to its size
- For user-defined types the alignment is equal to the greater alignment of one of its members (max. 8 bytes)
  - @ mod alignment = 0
    - 1 byte → 0x...X
    - 2 bytes → 0x...00, 0x...02, 0x...04 0x...06
    - 4 bytes → 0x...00, 0x...04, 0x...08, 0x...0A

Why alignment?

- Cons: Waste memory
- Pros: Huge increase in performance
  - CPU reads words (ie: 4 byte size)



Without alignment



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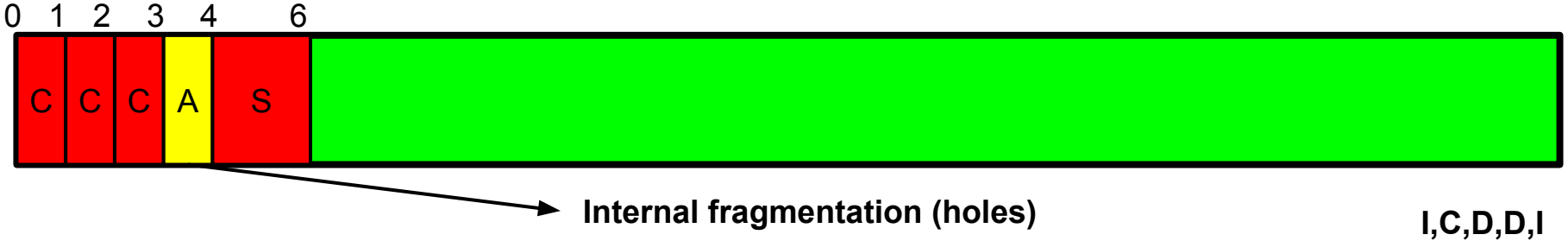

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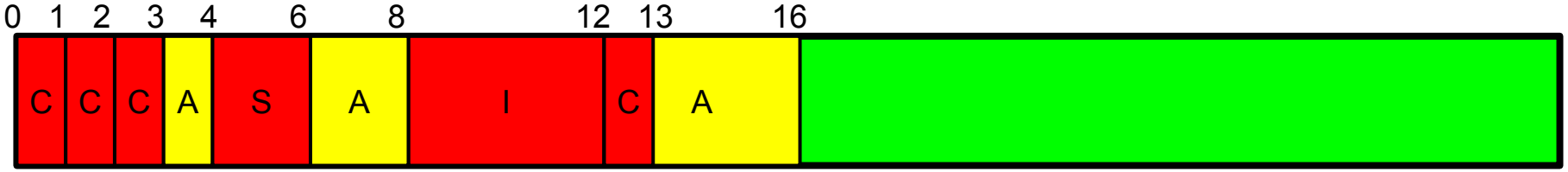

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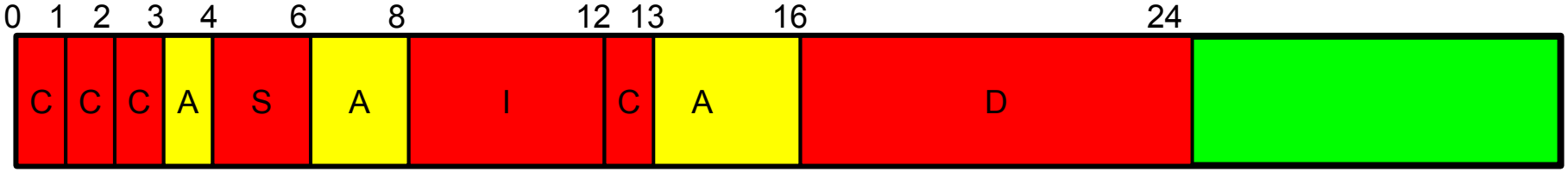

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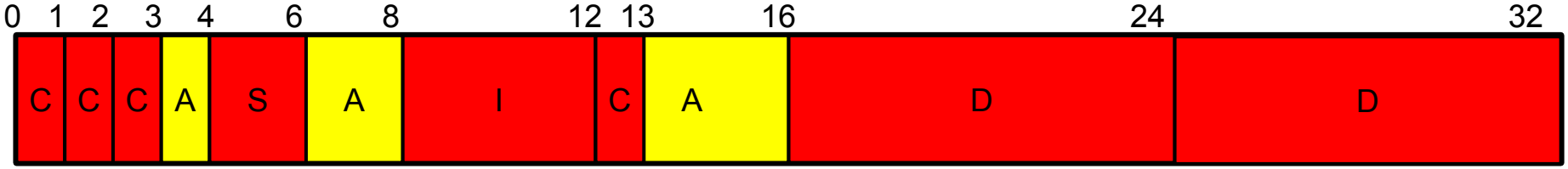

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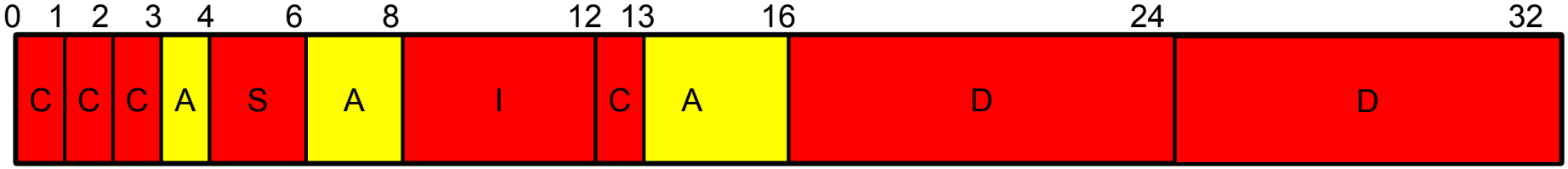

External fragmentation → Order matters

What about objects?

- Composition of multiple primitive types
- Object size
  - Sum of its members in aligned positions
- Object alignment
  - Equals to the greater alignment of its members

```
struct foo {
    bool b;      // S = 1
    int i;       // S = 4
};
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```
struct foo {    // S = 5
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    int i;      // S = 4
};
```

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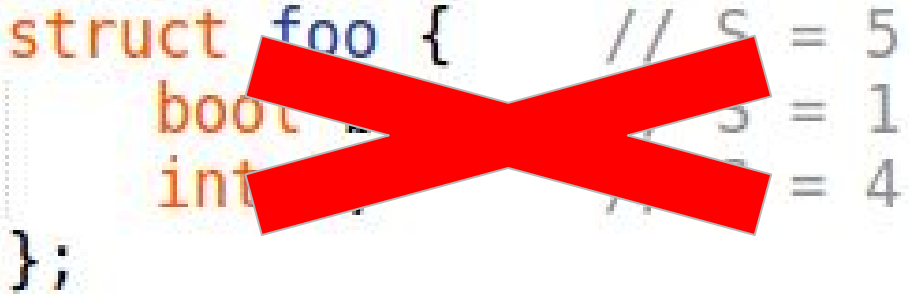

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};
```

```
struct foo {    // S = 8    A = 4
    bool b;     // S = 1
                // A = 3
    int i;      // S = 4
};
```

Another example

```
struct bar {
    double d;    // S = 8
    char c;      // S = 1
};
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struct bar {
    double d;    // S = 8
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struct bar {     // S = 9     A = 8
    double d;    // S = 8
    char c;      // S = 1
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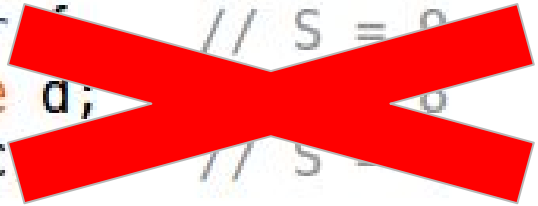

Keep memory aligned!

Another example

```
struct bar {
    double d;    // S = 8
    char c;      // S = 1
};
```

```
struct bar {     // S = 16   A = 8
    double d;    // S = 8
    char c;      // S = 1
};
```

Tips and Tricks

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Dynamic Memory Tip#1: Dynamic Memory is not supported for Windows XP guests
Dynamic Memory Tip#2: Only Enterprise and Ultimate editions of Windows 7 and Vista are supported guests.
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Dynamic Memory Tip#5: You need to update both the Hyper-V host AND the guest to use DM for most OSes.
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Dynamic Memory Tip#9: For Windows 7 and Windows Server 2008 R2 you only need to install SP1 to enable DM.
Dynamic Memory Tip#10:Almost always there is no reason to set 'Memory Priority' in VDI scenarios.
Dynamic Memory Tip#11: VMs must be powered off of change/enable Startup RAM and Maximum RAM
Dynamic Memory Tip#12: Memory Buffer and Memory Priority can be changed while guest is running.
Dynamic Memory Tip#13: Setting DM on a VM that does not support it will result in the VM ignoring all but the Startup RAM config. This will be the traditional maximum memory.
Dynamic Memory Tip#14: Enable the Memory Buffer if you have DM performance problems and have I/O-intensive applications and services.
Dynamic Memory Tip#15: DM is most effective when you determine the RAM needed to just successfully boot and set Startup RAM to that value.
Dynamic Memory Tip#16: If the Hyper-V host is part of a failover cluster, Hyper-V also reserves enough memory to run the failover cluster services.
Dynamic Memory Tip#17: Know that adding a RFX adapter adds a significant amount of RAM. Be sure to review Startup RAM at that time.
Dynamic Memory Tip#18: Setting Startup RAM too low is bad. Real bad. Your VM will not boot and there is no descriptive message on the VM.
Dynamic Memory Tip#19:When you use DM in a VM, don't trust Task Manager anymore for the available memory. It only sees the Startup RAM.
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To be continued (next week)...Beating malloc!