Optimizing Flex Applications

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most optimizations can be split into 2 categories

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Memory

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Memory
Performance

most optimizations can be split into 2 categories

Memory
Performance

but garbage collection affects both

Garbage Collection Empirical Model

Why empirical?

Why empirical?

- this is a description of *how we think* the garbage collection works in the player

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- this is *not* an exact technical description

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- this is *not* an exact technical description
- the actual behavior is complex and difficult to describe
- the player may change it at some point
- this model worked for us so far

Memory Allocation

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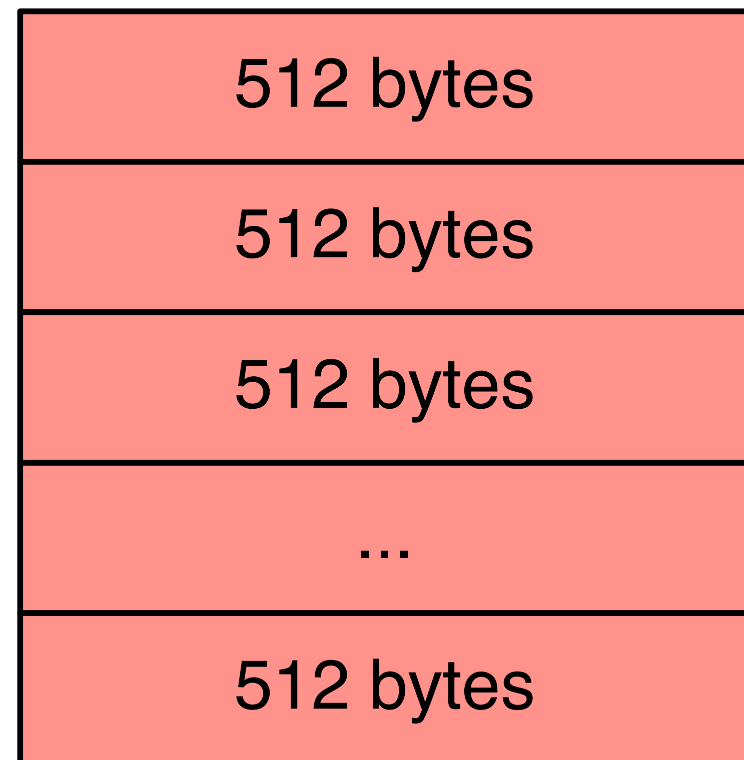
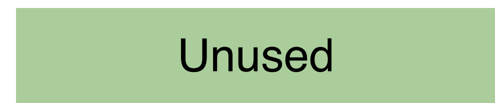
Memory Allocation

- most Flash applications need to allocate small chunks of memory of common sizes, but...
- small frequent OS memory allocations can be slow
- Flash grabs large chunks of memory from the OS less often
- single large chunk is split into a pool of small blocks of a fixed size
- big chunks for Bitmaps, Files, etc. are not pooled

after a pool is used up another large chunk is allocated from the OS





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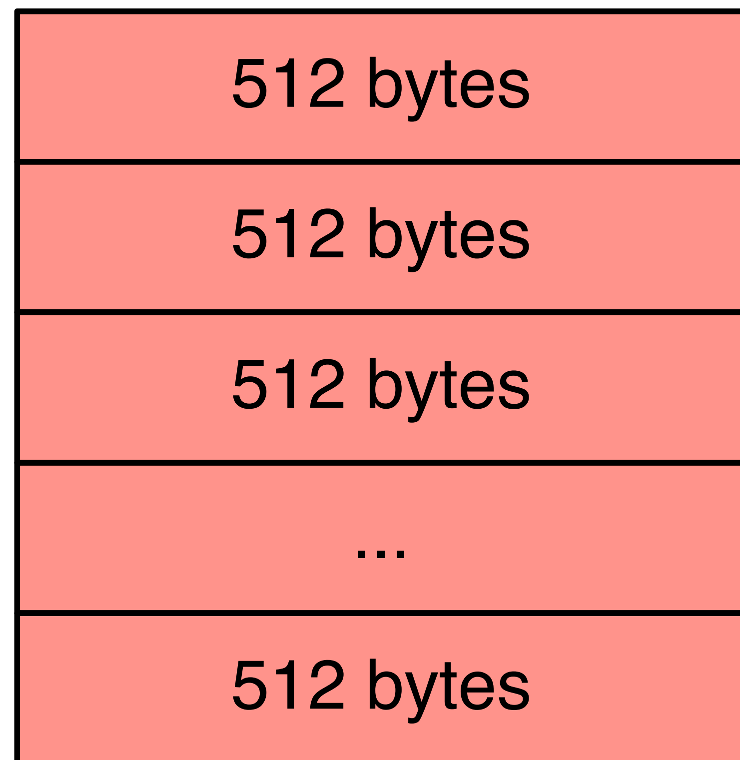

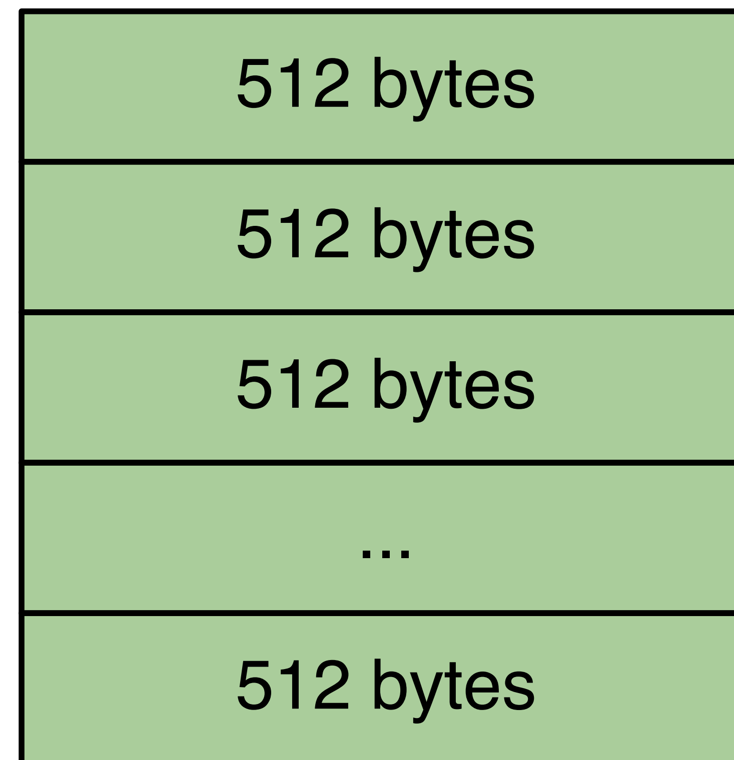

Used

Unused

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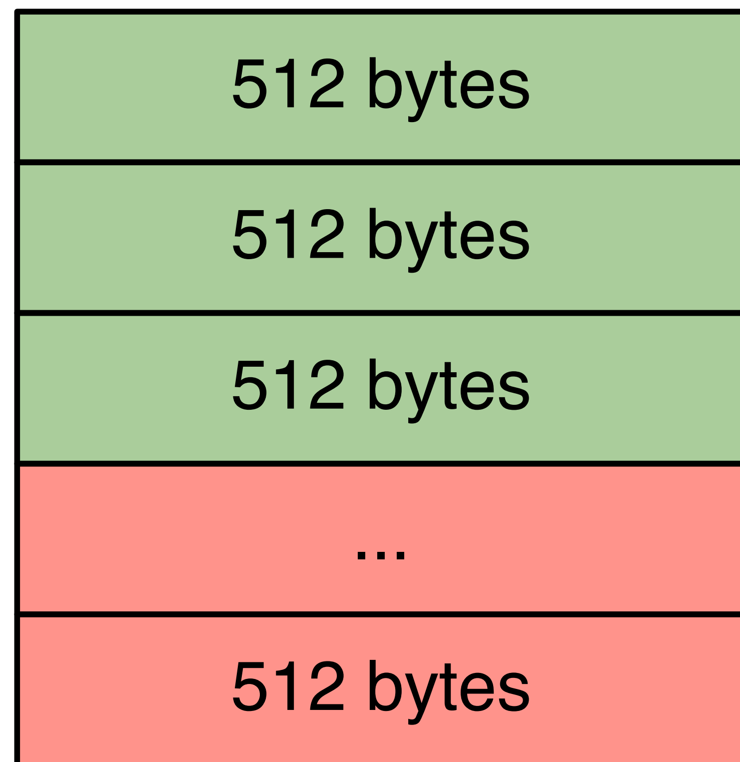
GC doesn't run Interactively



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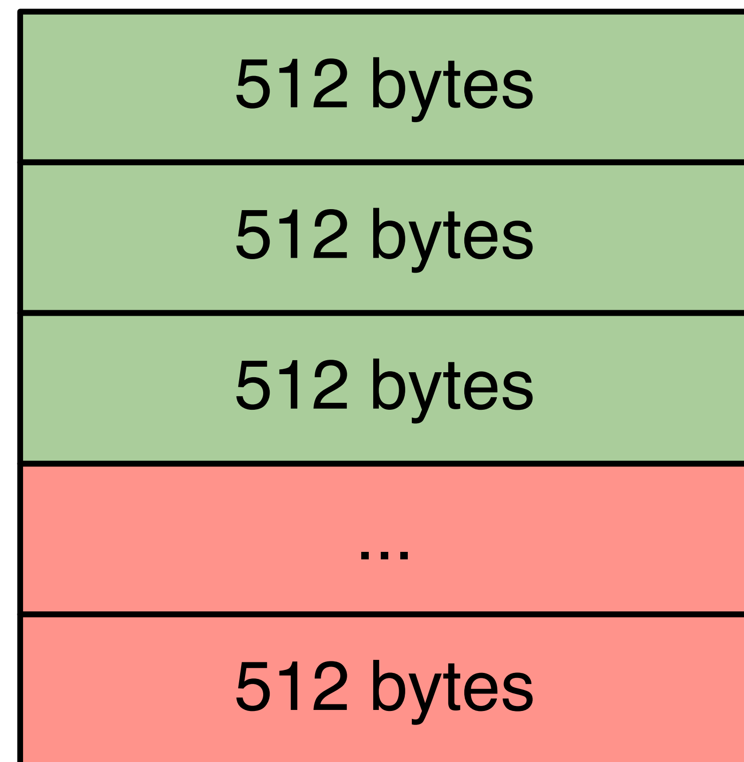

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- lets assume that Foo's instance is 512b

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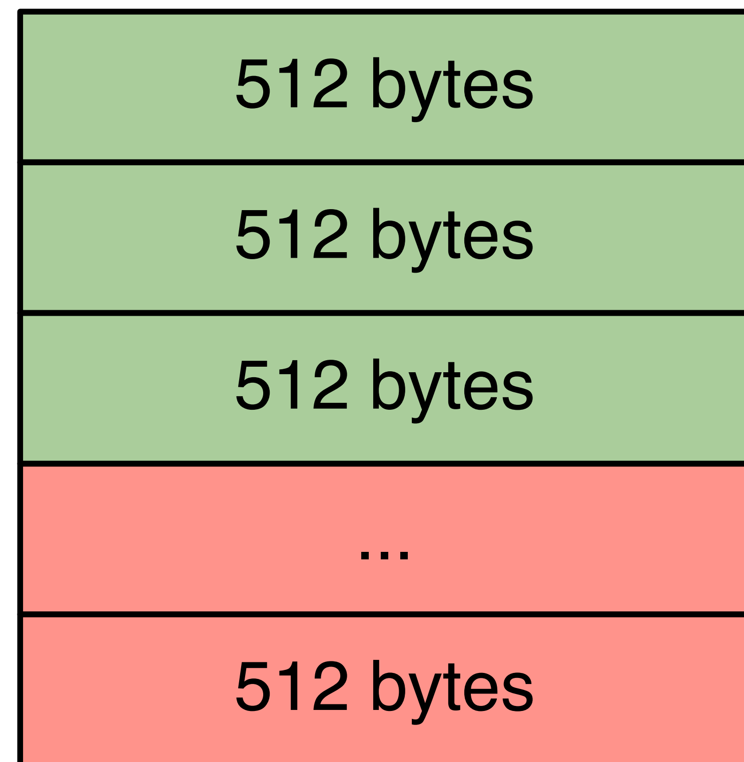

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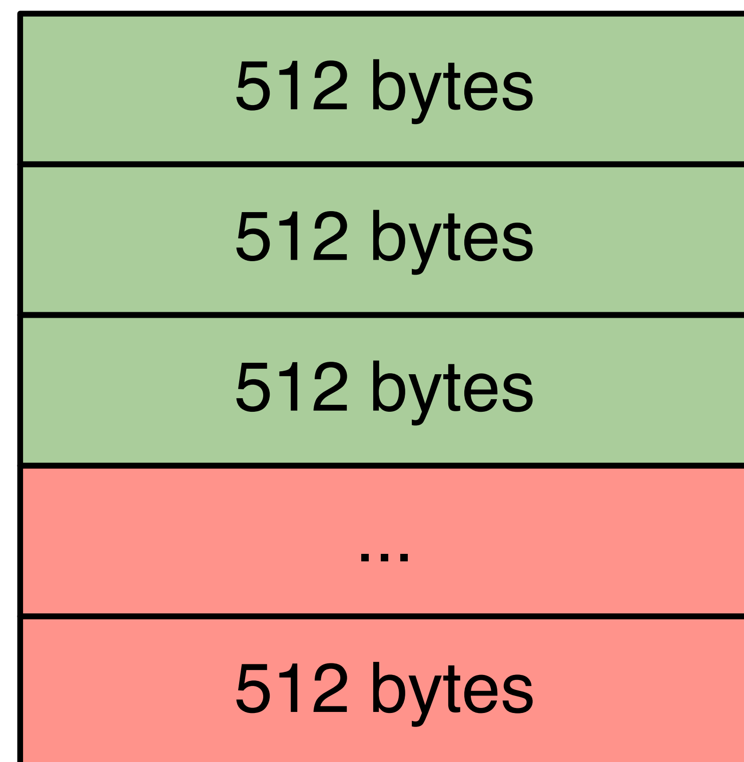

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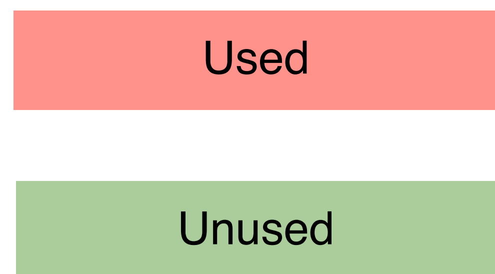

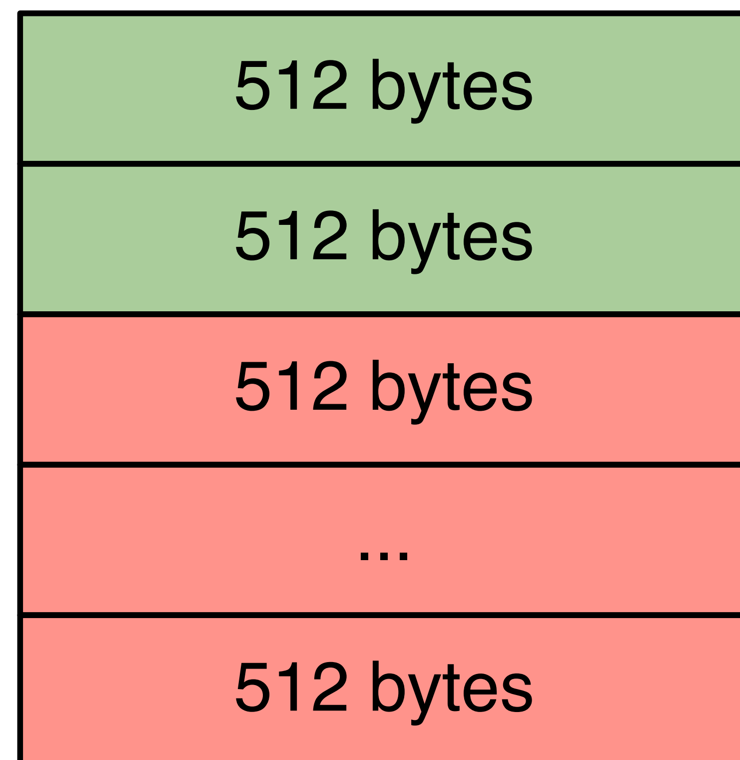

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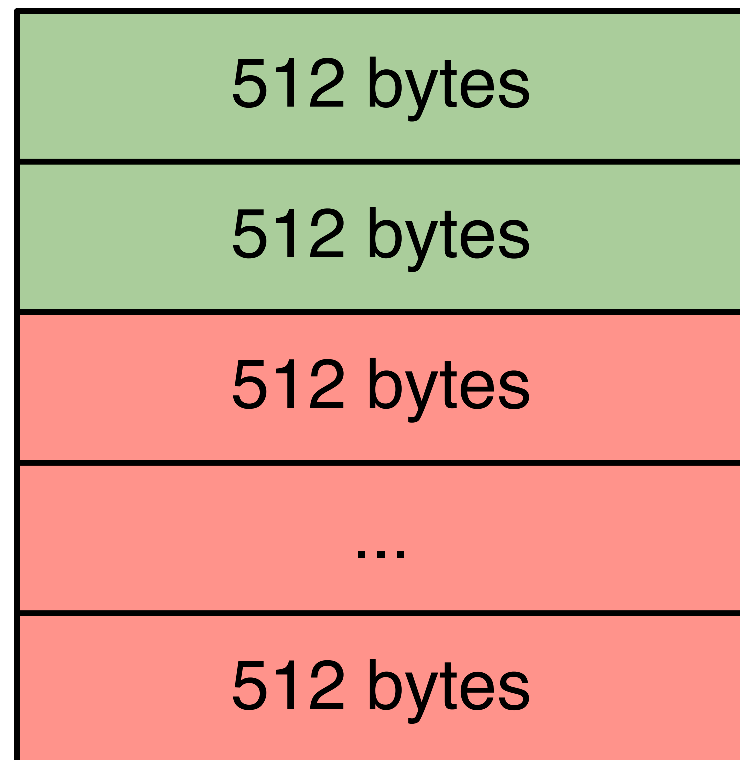

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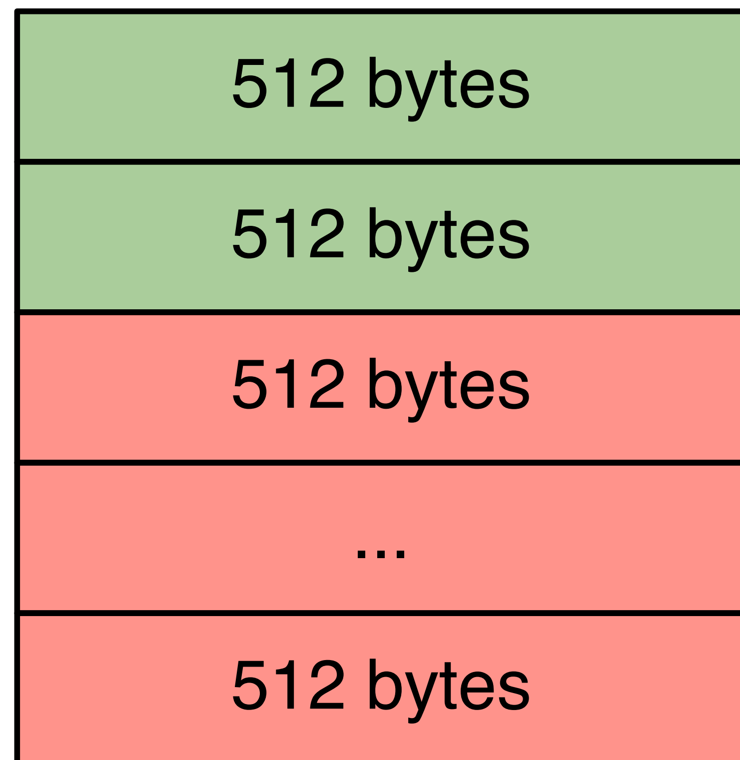

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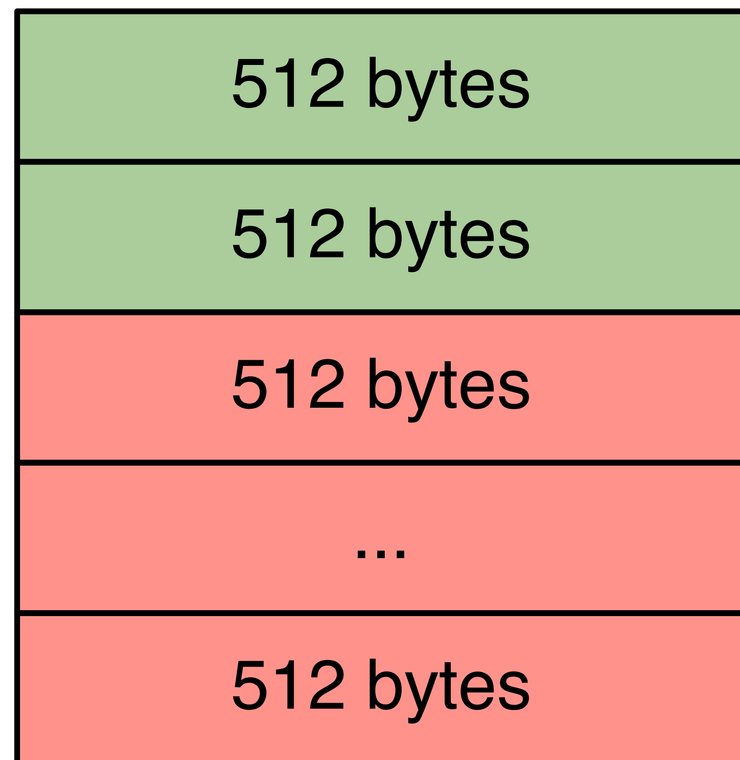

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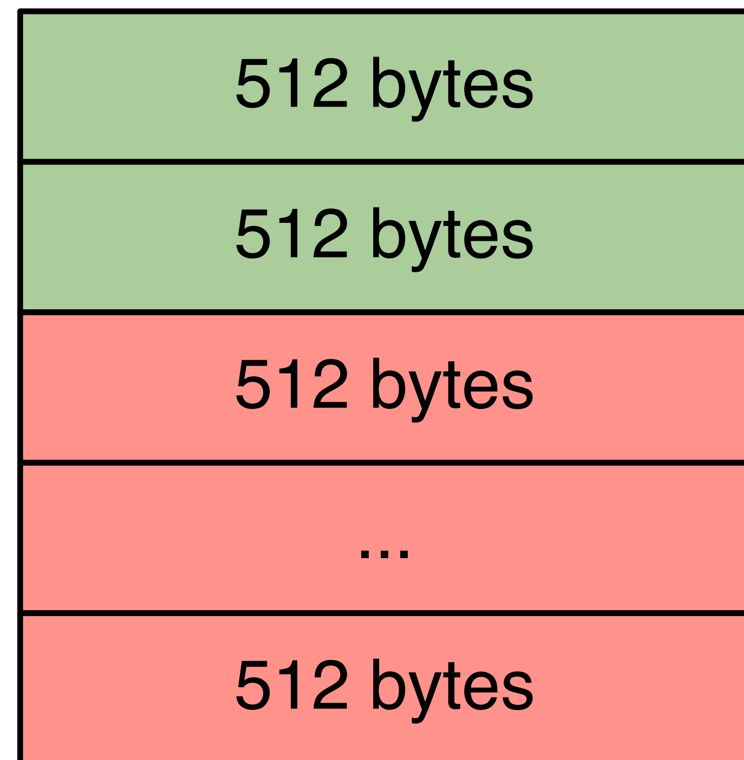


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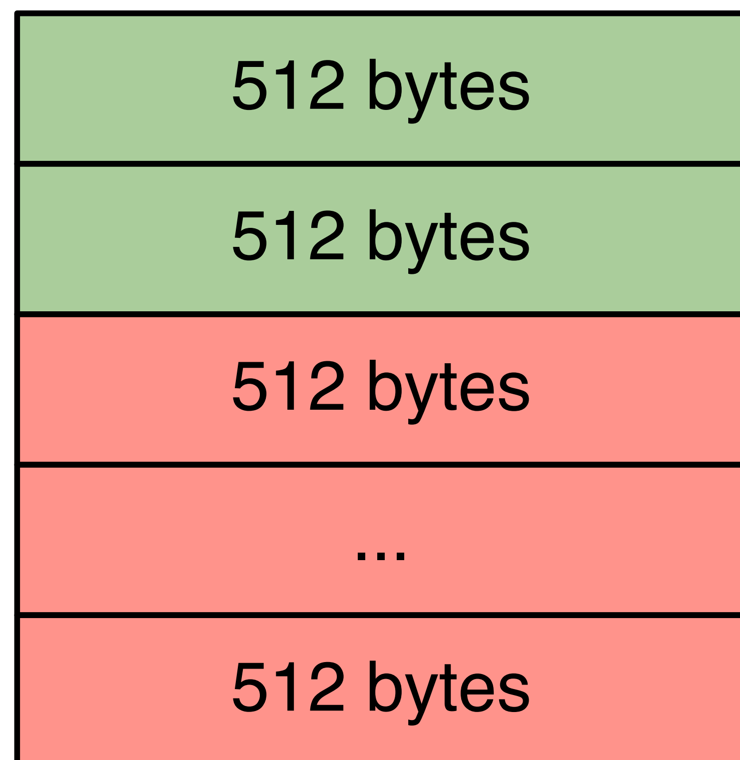

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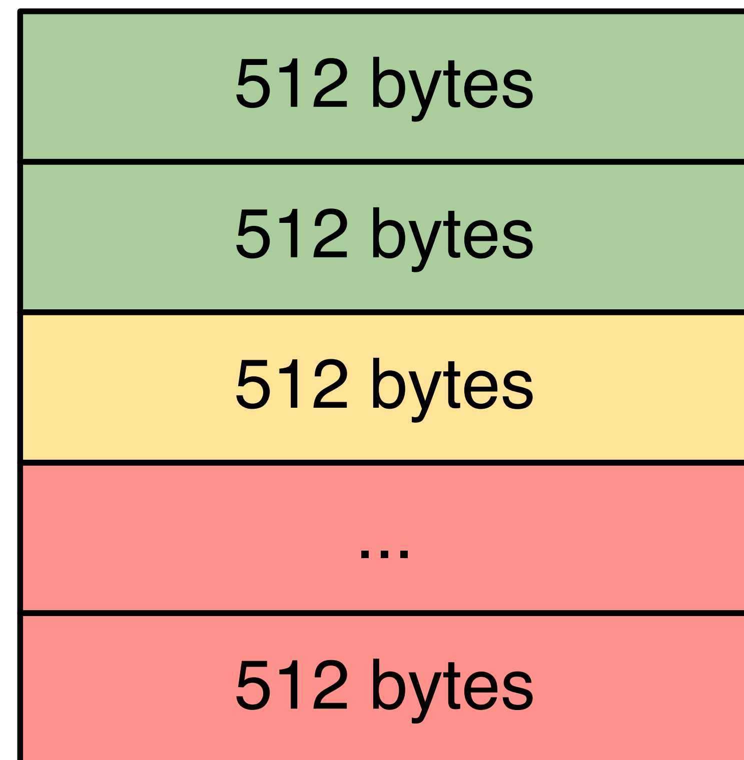


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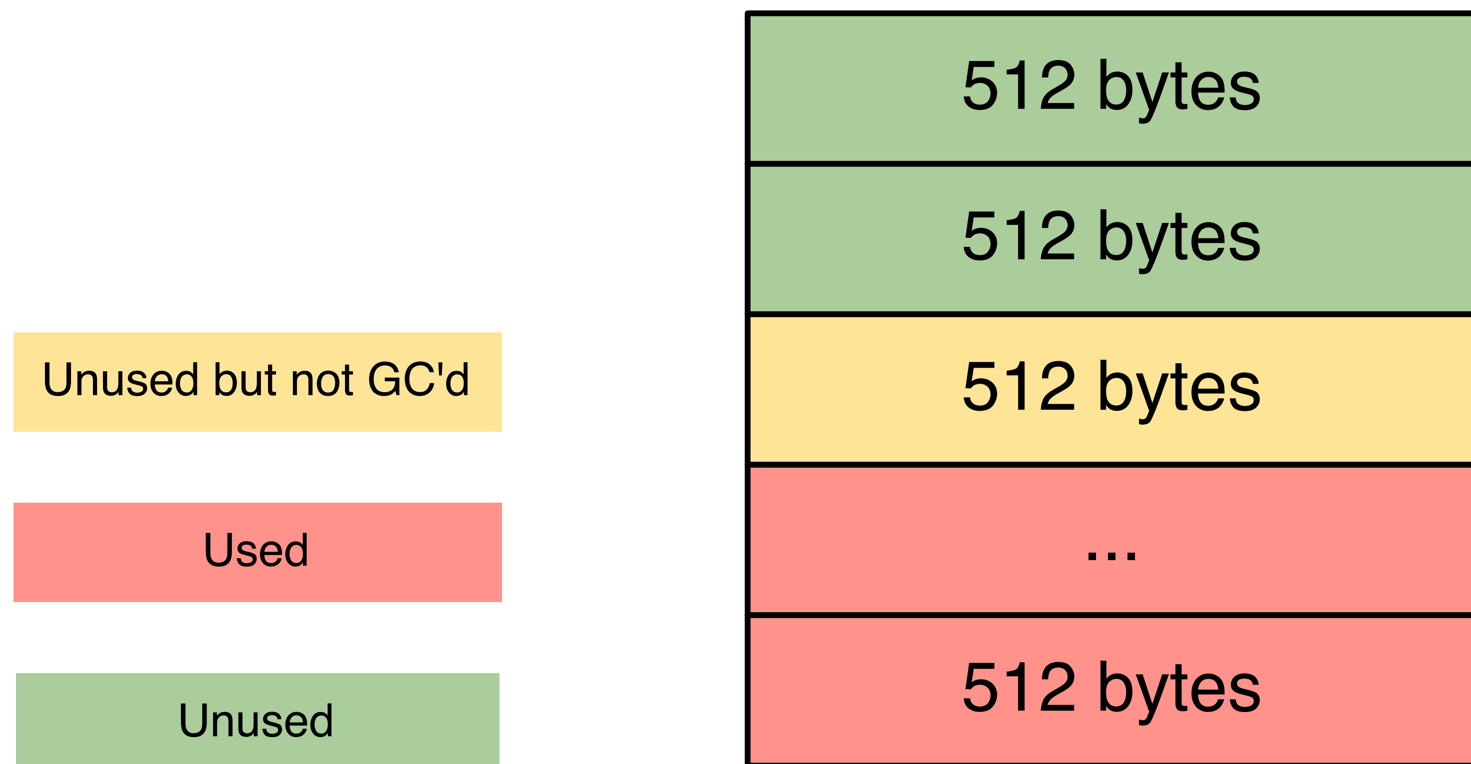


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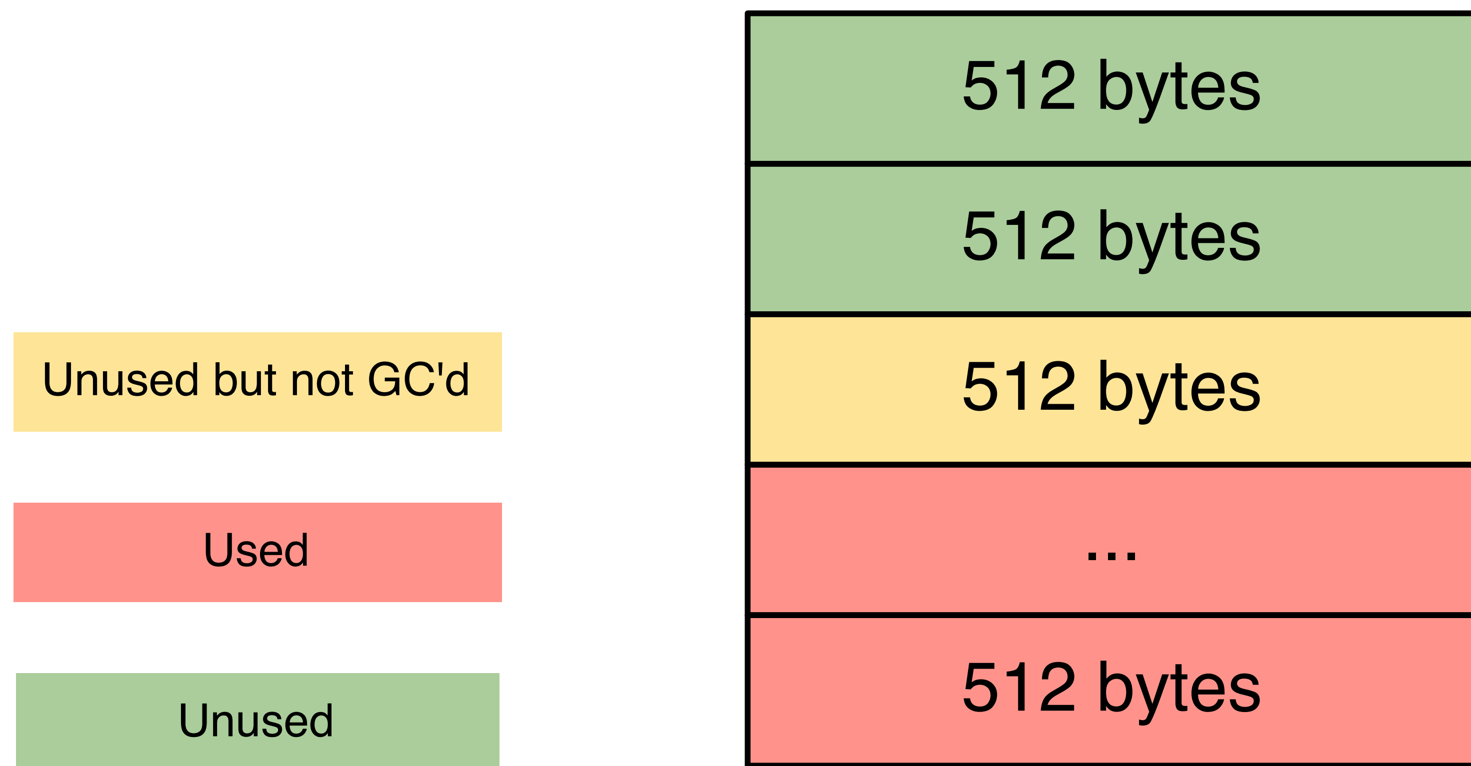

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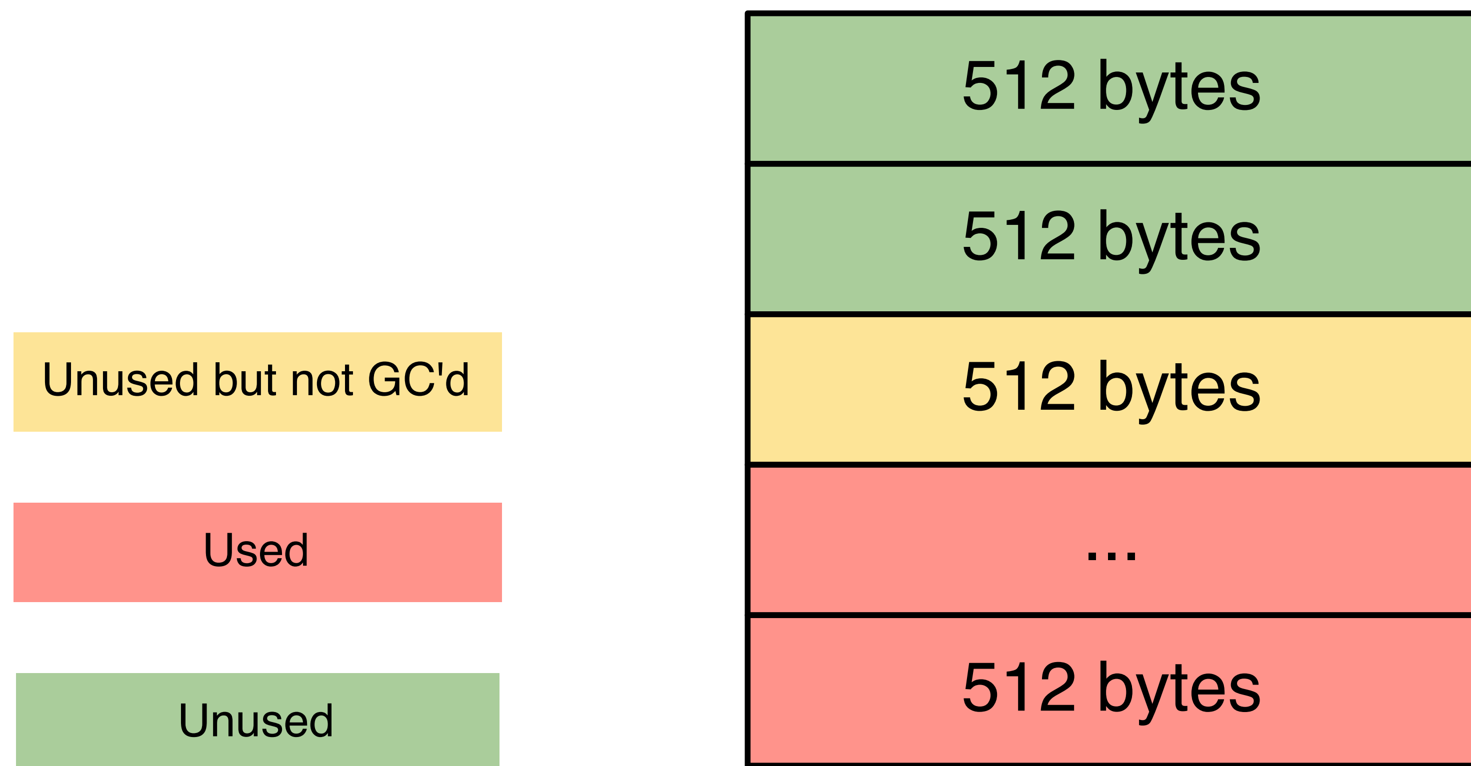
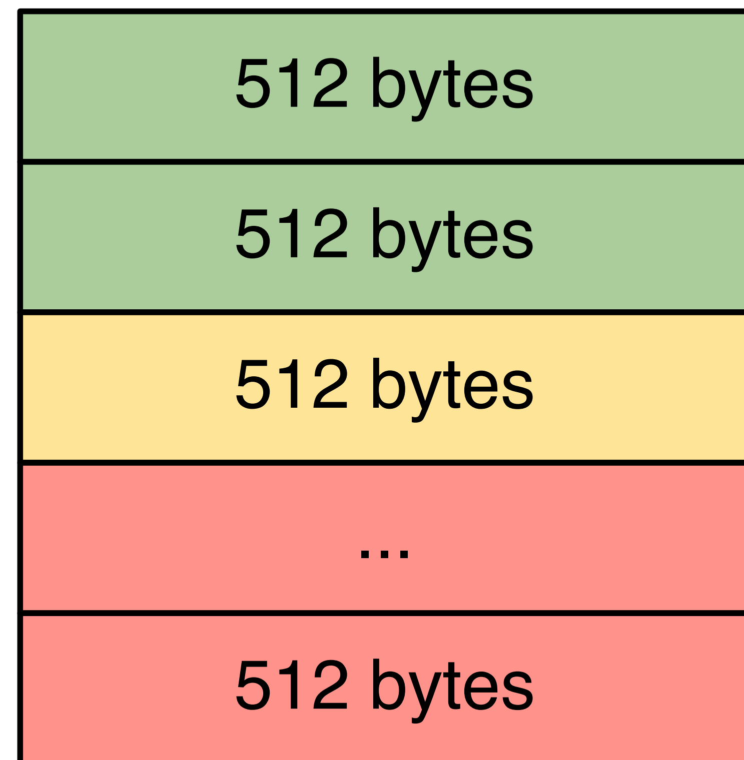


GC doesn't run Interactively

Unused but not GC'd

Used

Unused

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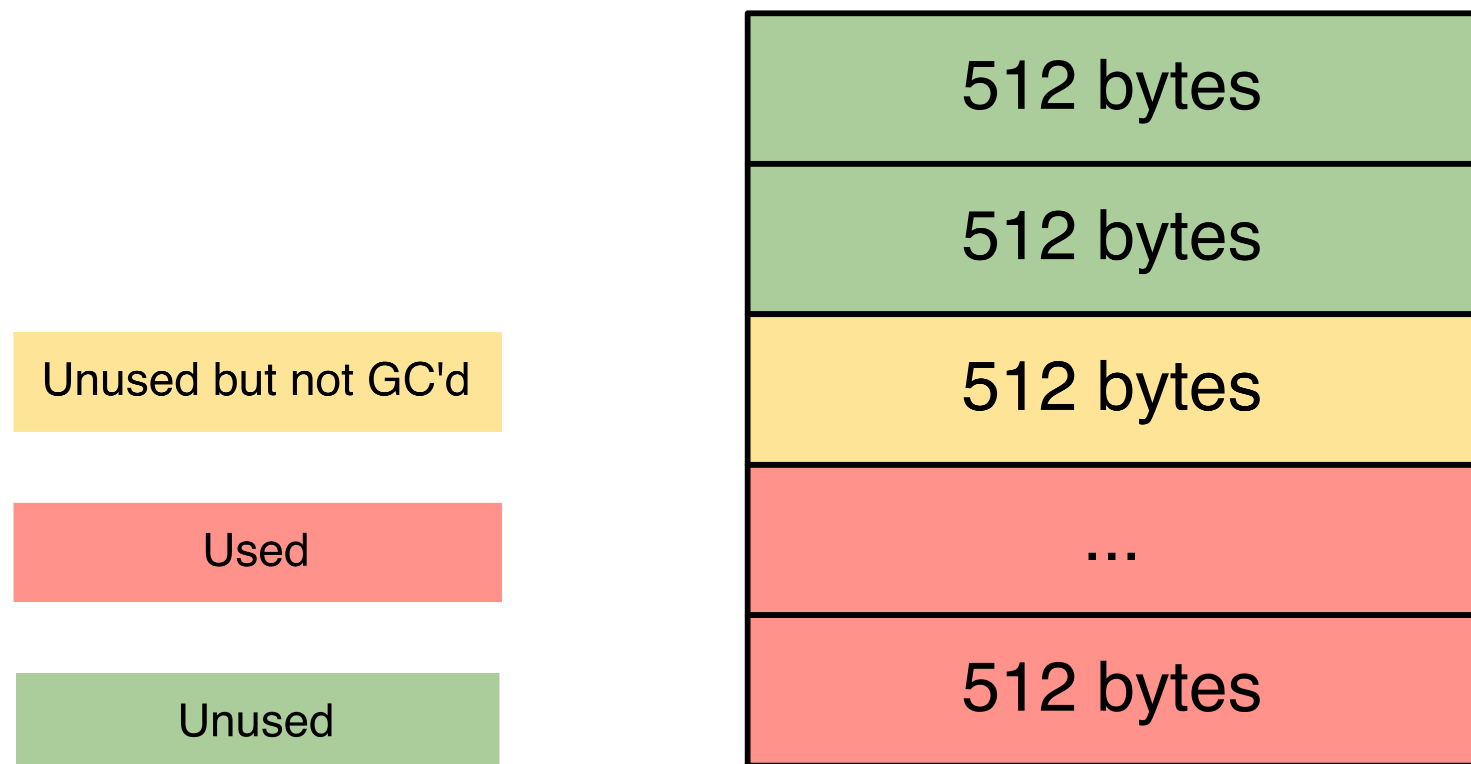


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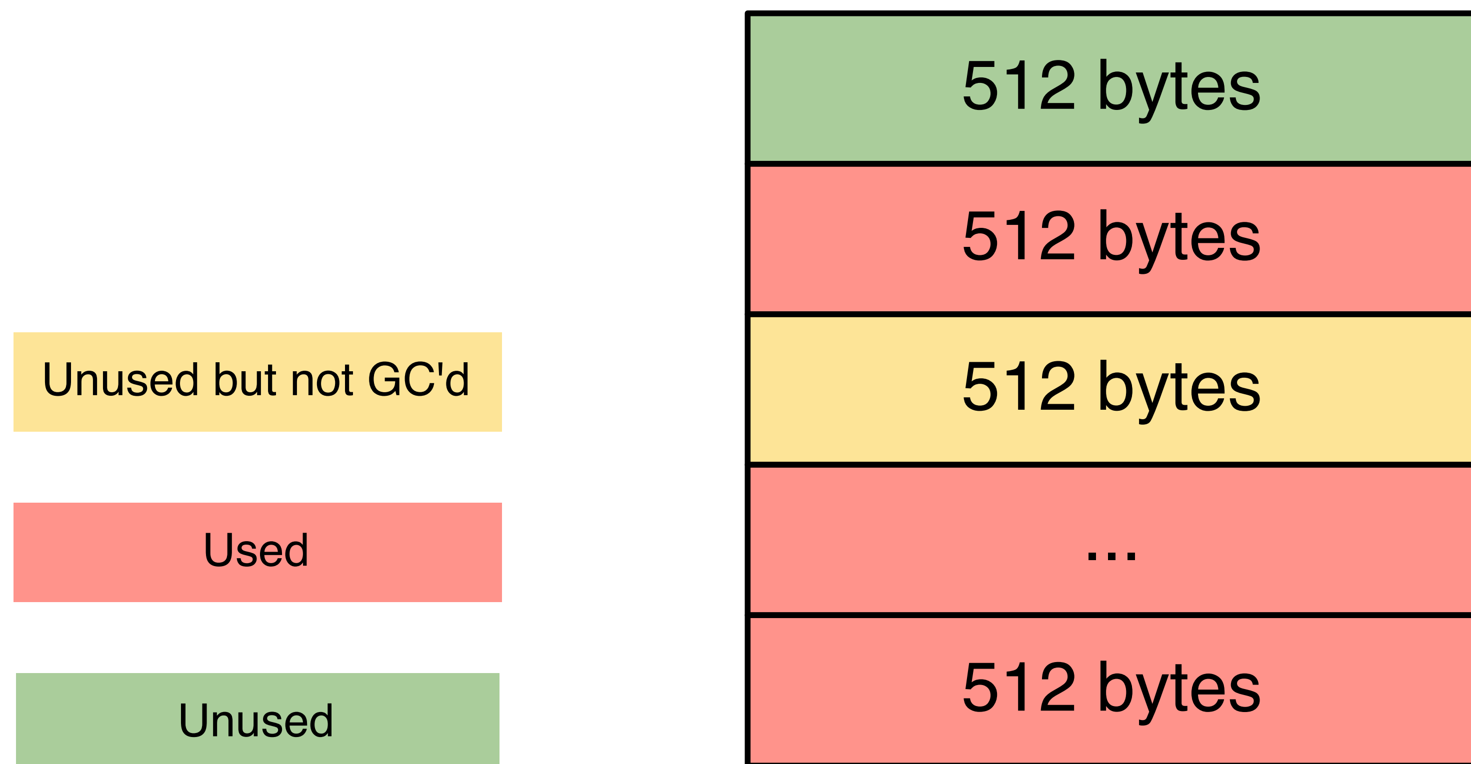


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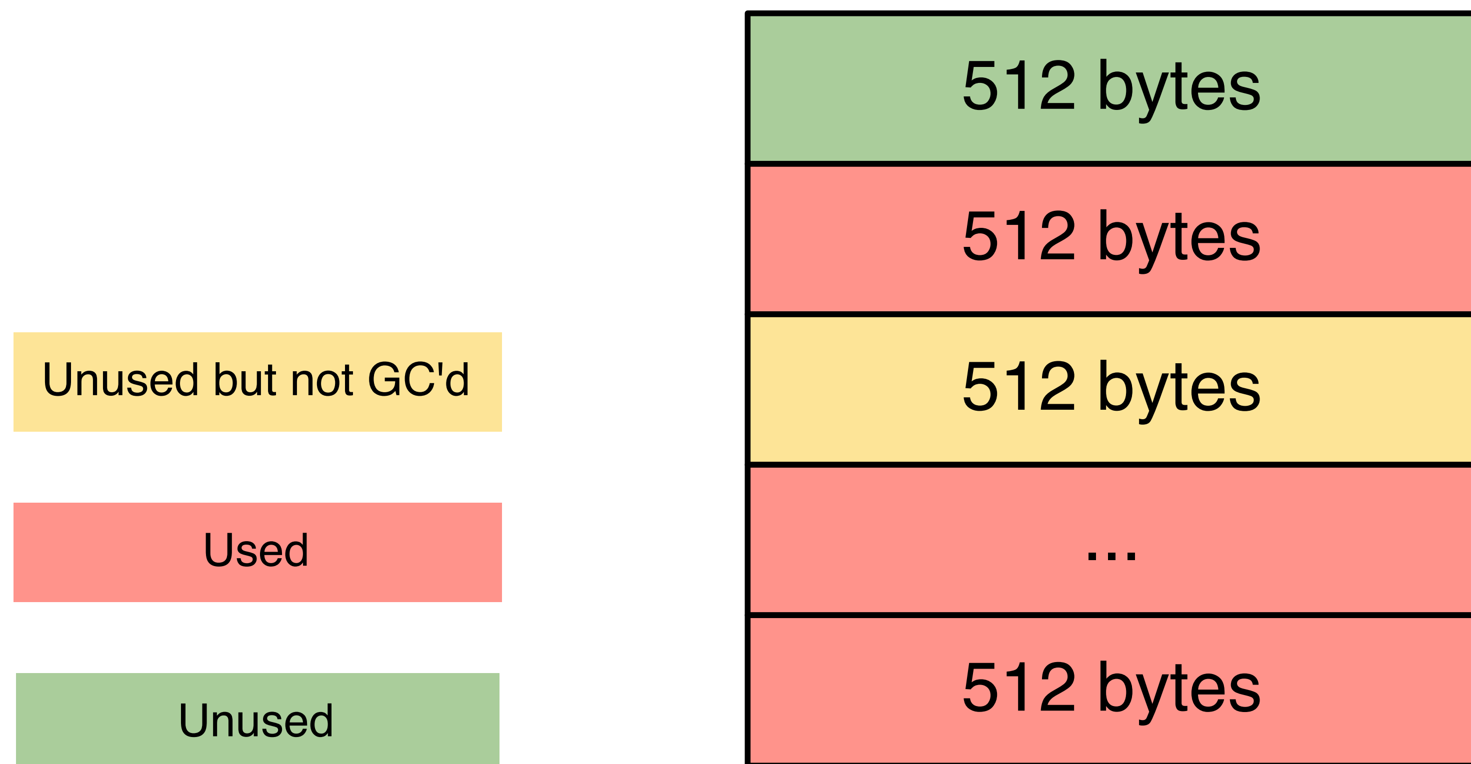


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foo = new Foo();
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- when another Foo is allocated it might take a new block from the pool
- memory consumption grows

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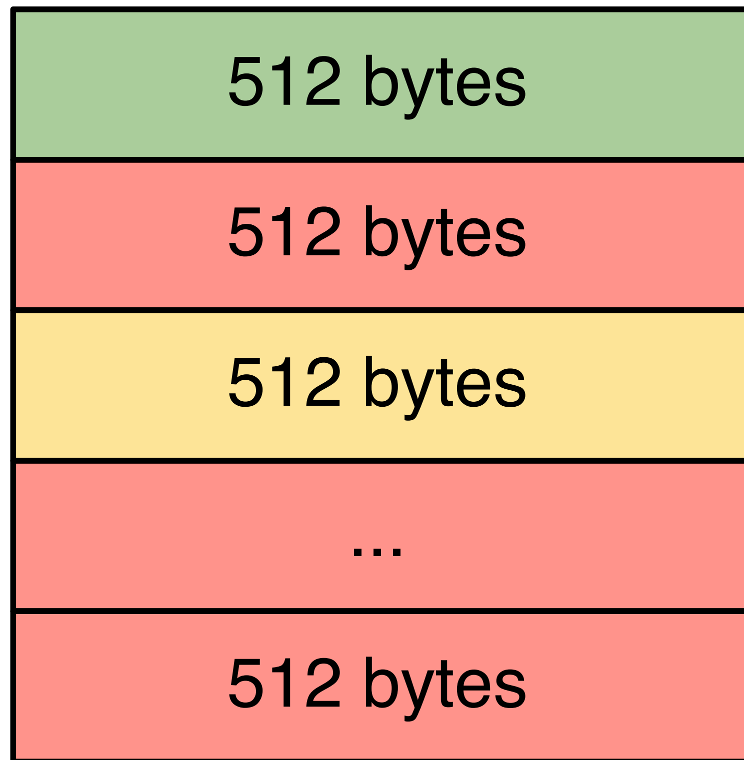
Unused but not GC'd

Used

Unused



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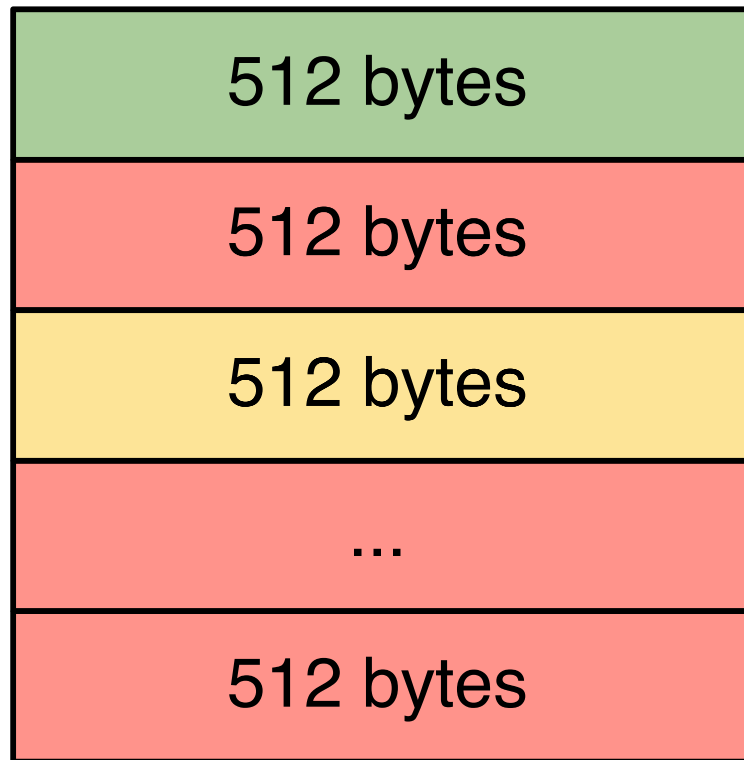
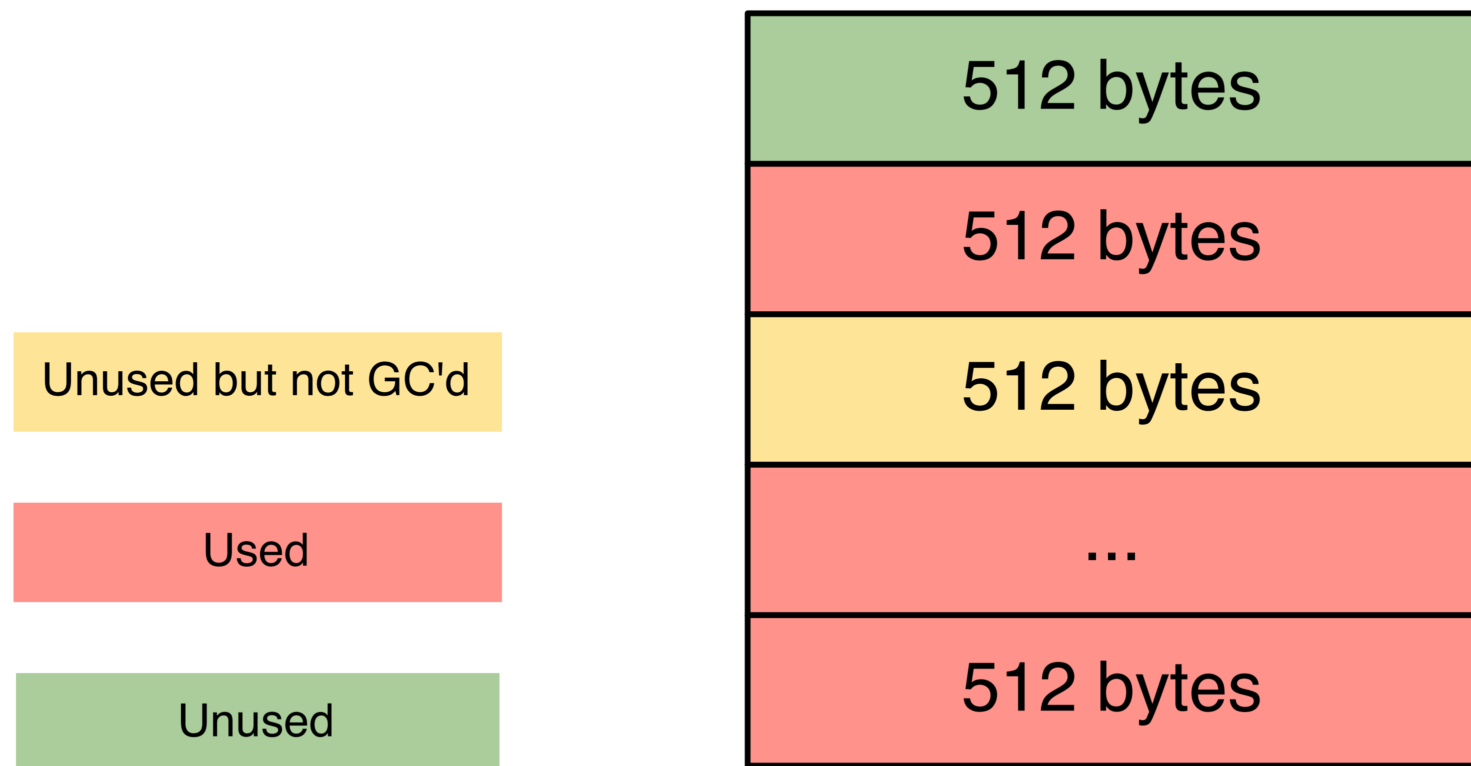


GC is only triggered by Allocation



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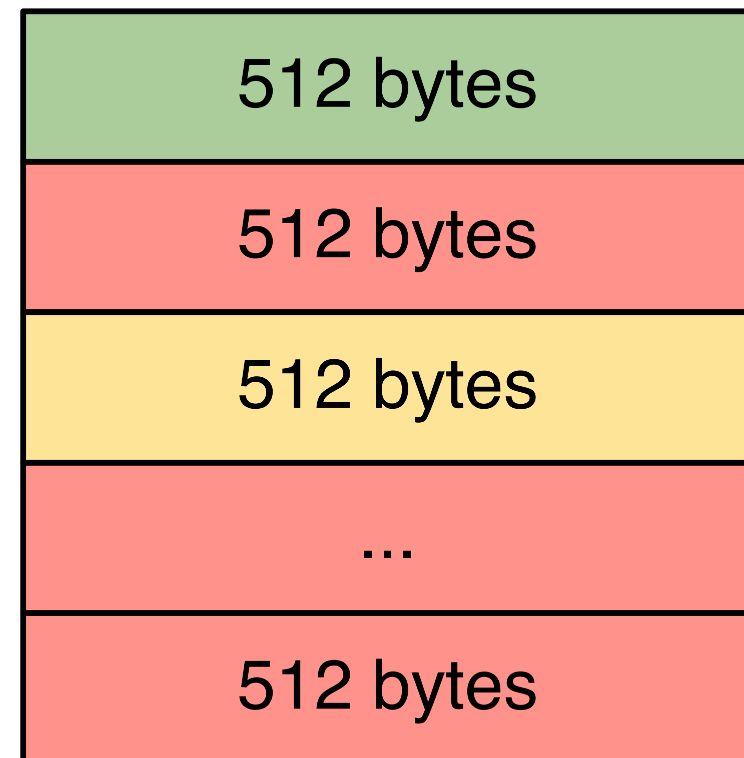

when the pool start to fill up GC will attempt to run before OS allocation

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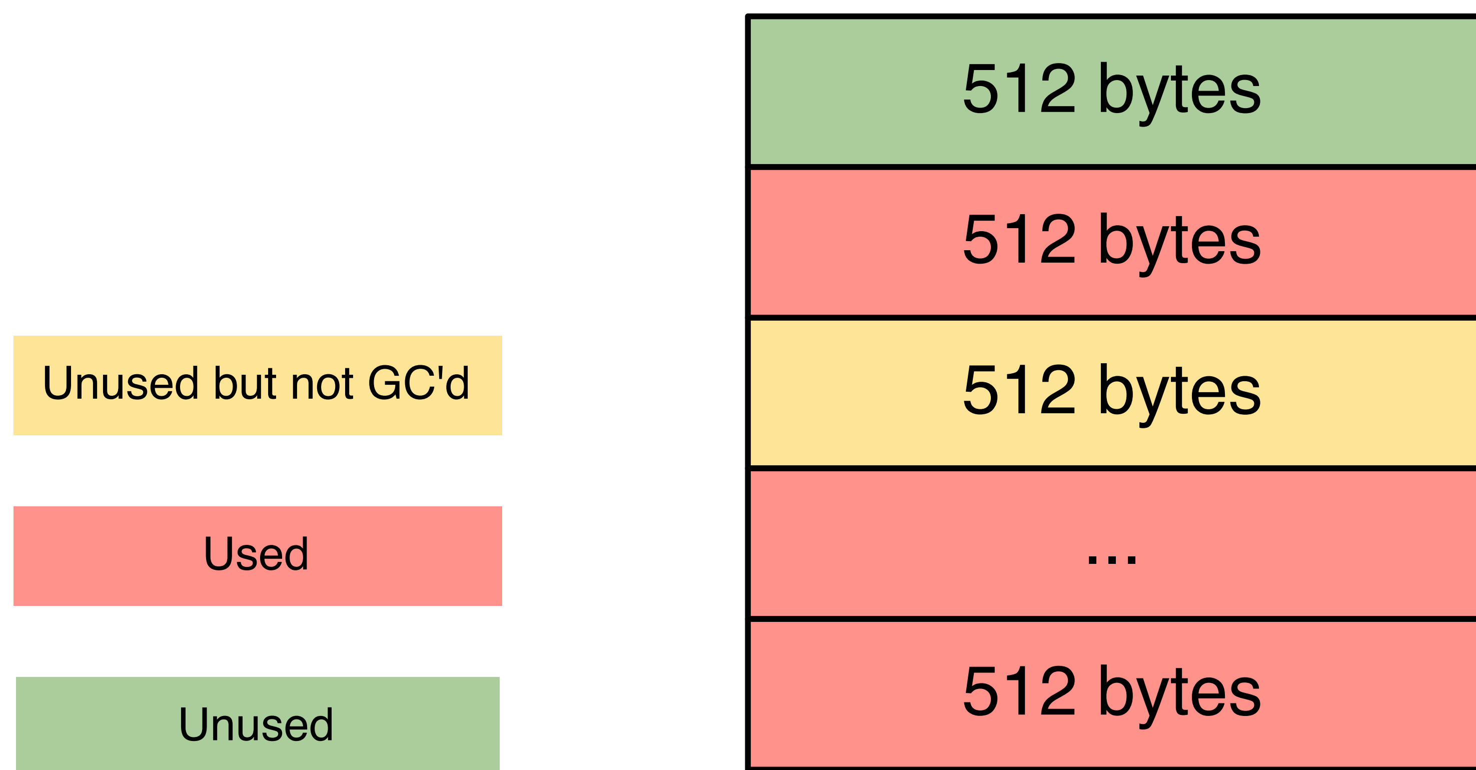

Almost out!
Run GC!

when the pool start to fill up GC will attempt to run before OS allocation

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Since GC is only triggered by allocations the memory usage of an idle application will never change

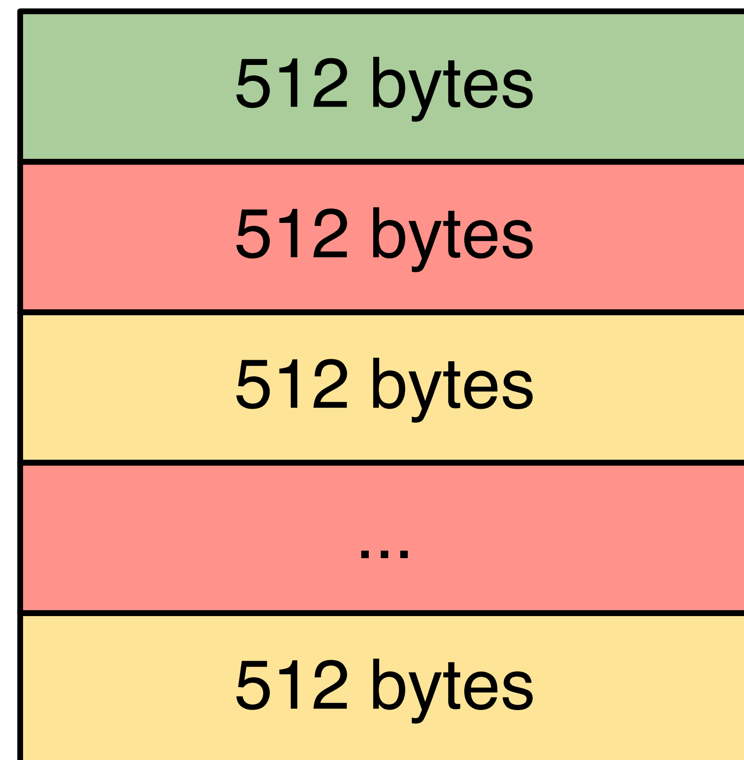
GC doesn’t run Completely

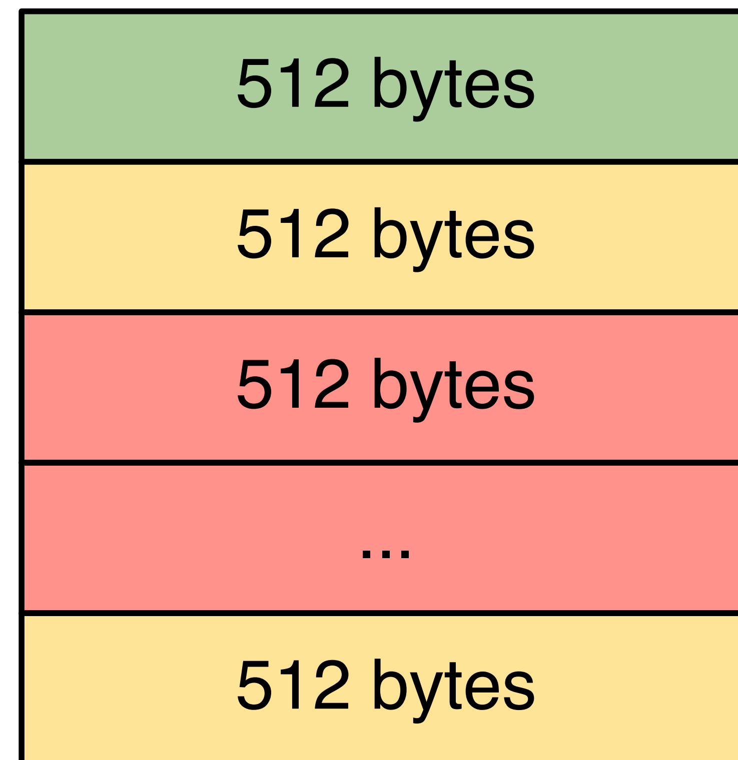
memory before GC

Unused but not GC'd

Used

Unused





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GC doesn’t run Completely

memory after GC

Unused but not GC'd

Used

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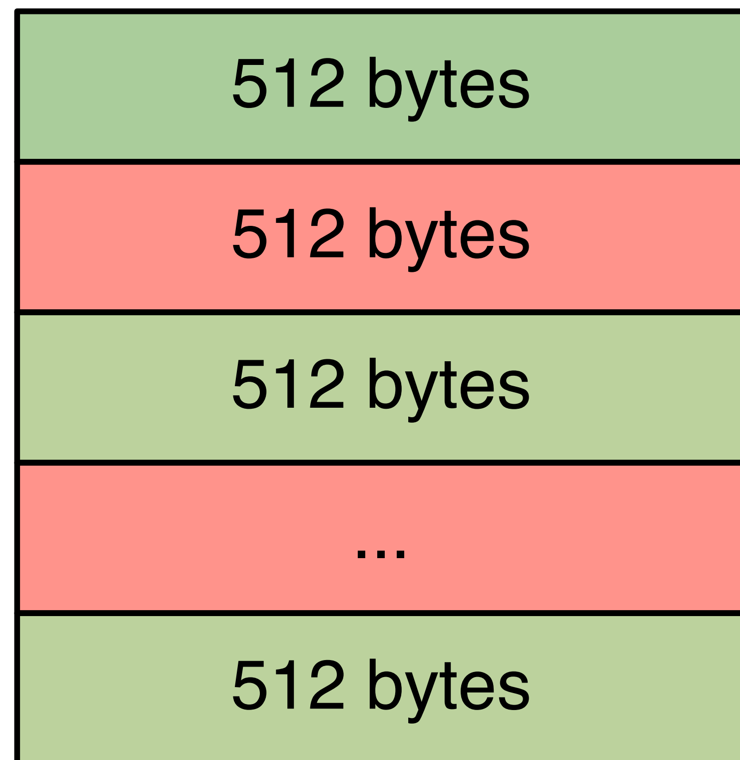

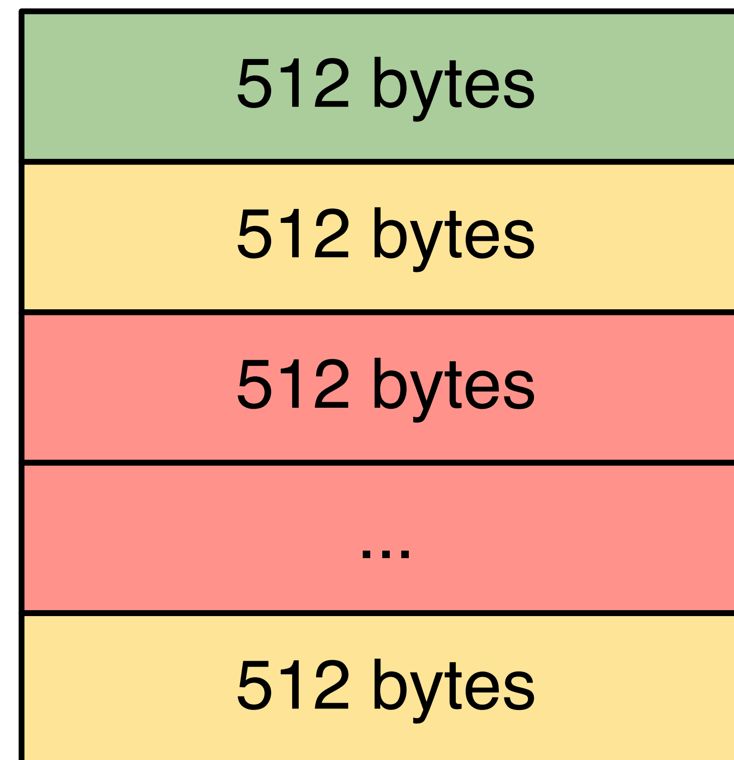

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- the GC must not interfere with rendering and interaction
- memory may never return to the initial point

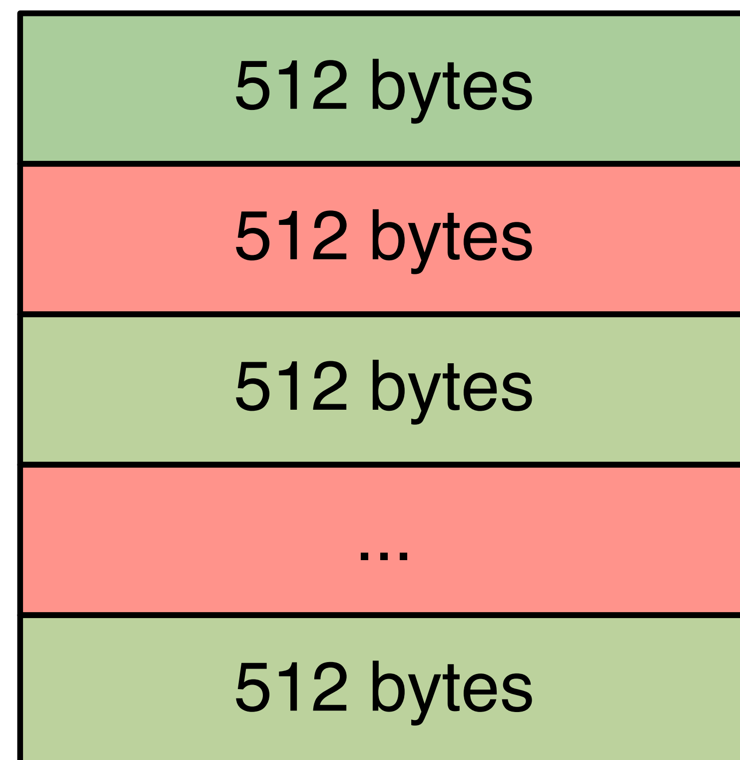
GC doesn't always free OS memory

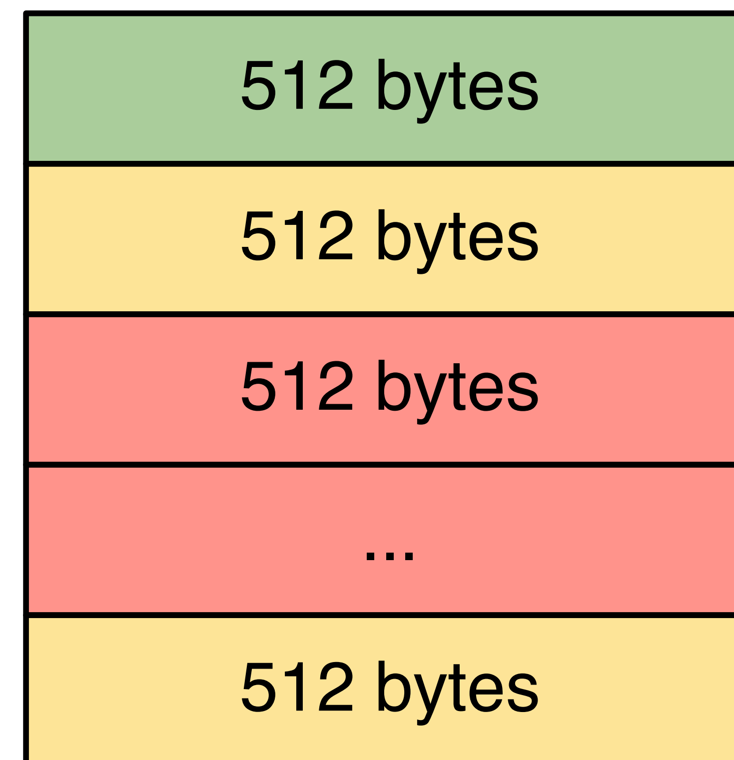
memory before GC

Unused but not GC'd

Used

Unused





GC will attempt to move blocks from one big chunk to another

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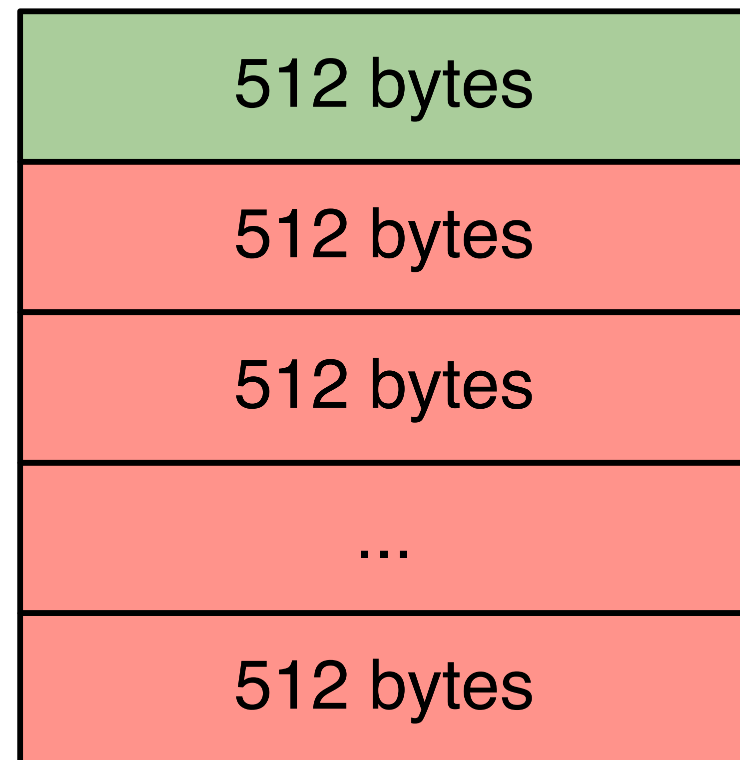
GC doesn't always free OS memory

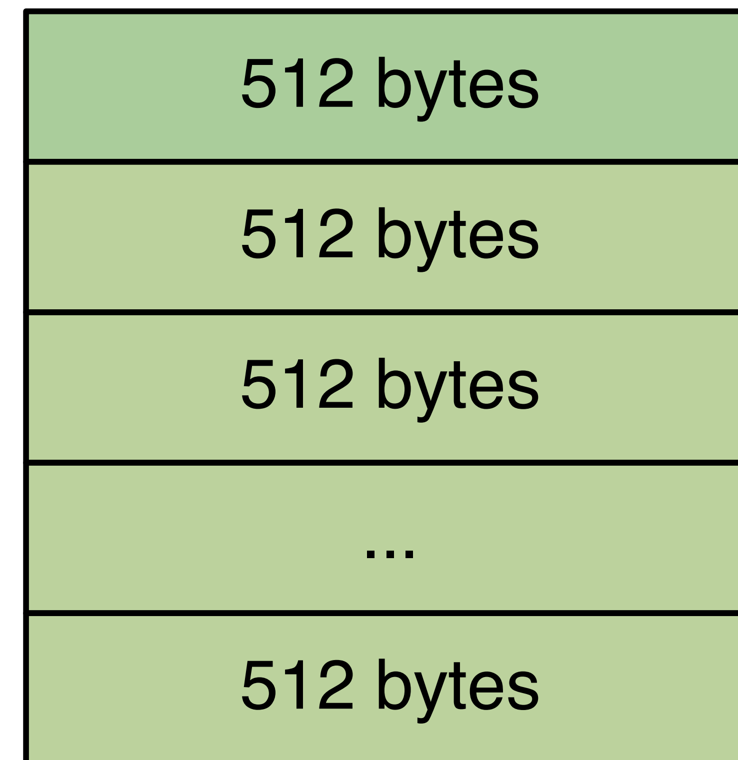
memory after GC

Unused but not GC'd

Used

Unused





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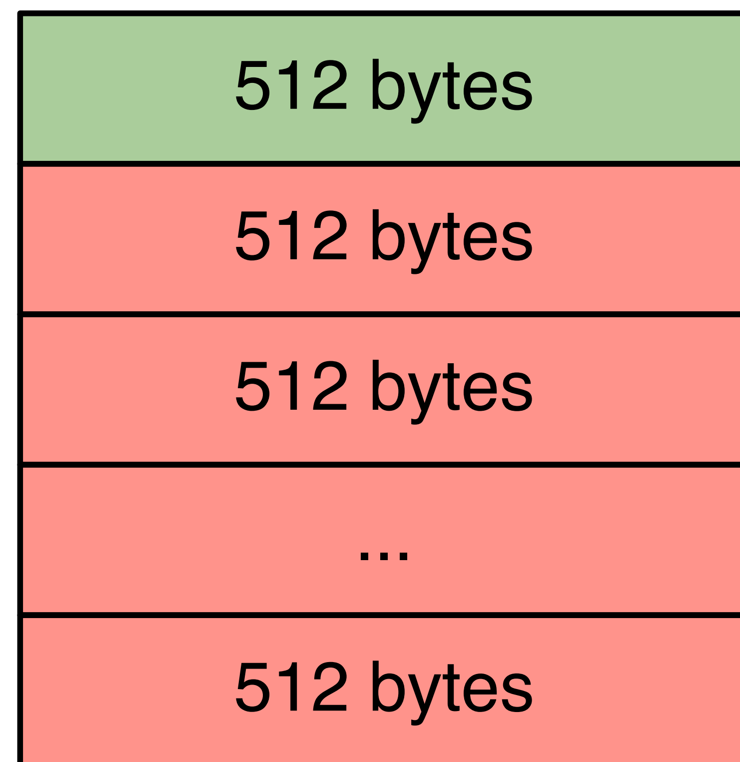

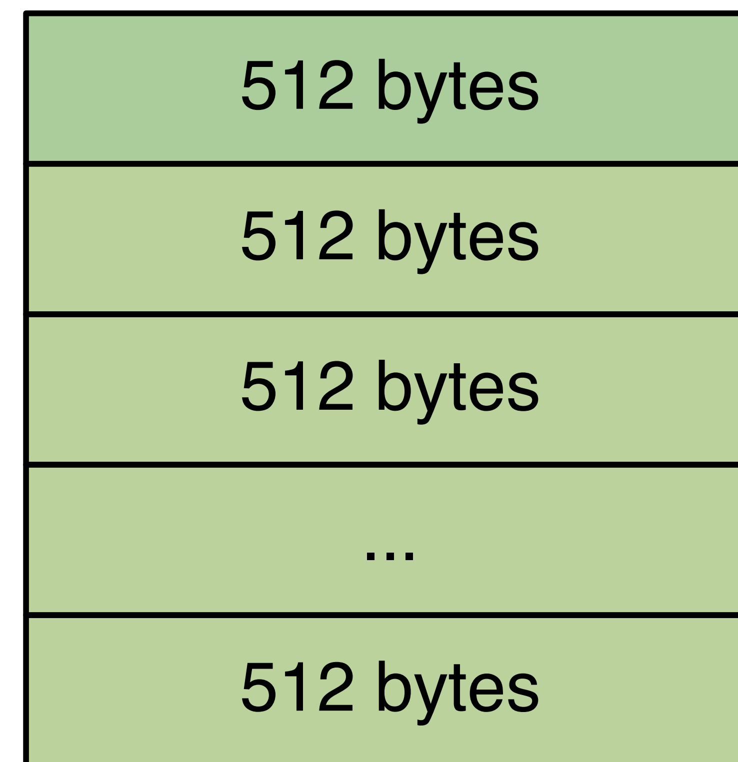

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GC is not predictable, so how to detect memory leaks?

Detecting Memory Leaks

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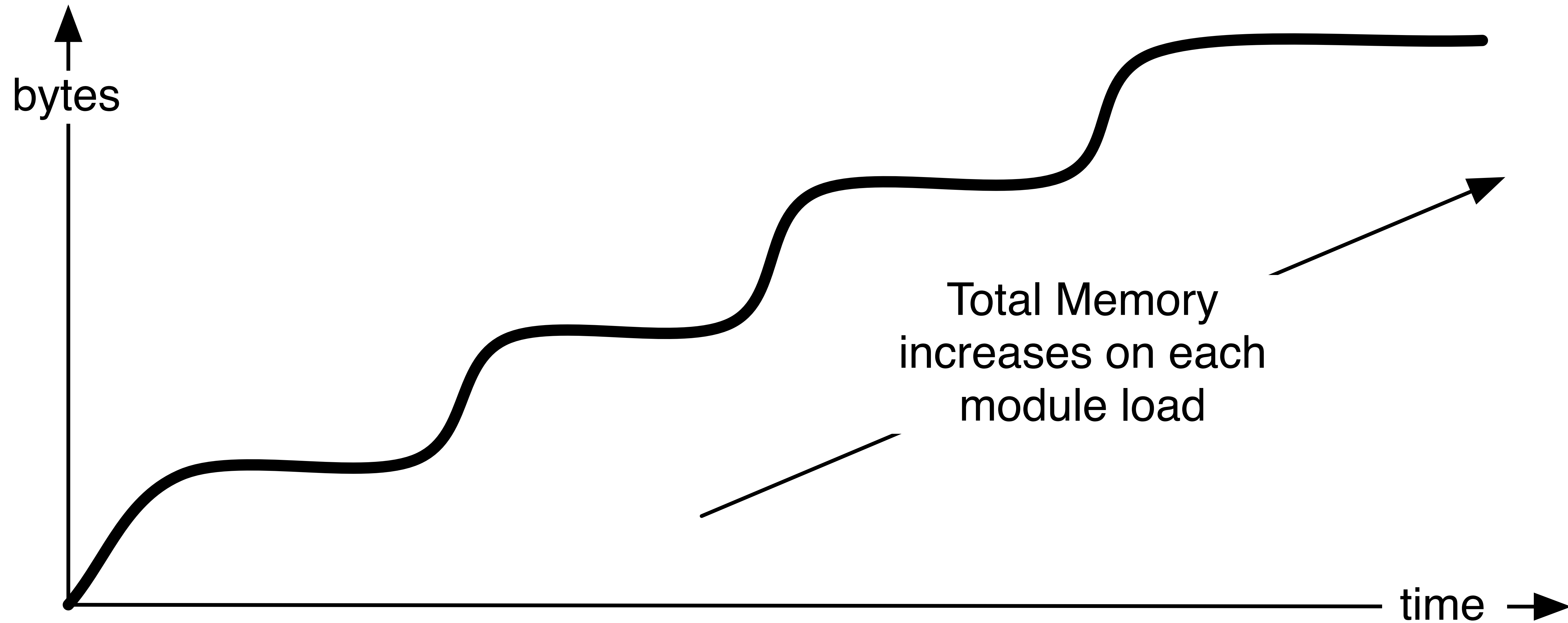
  - loading and unloading modules
- repeat these sequence long enough and observe how it does affect total memory used

Leaking Memory Pattern



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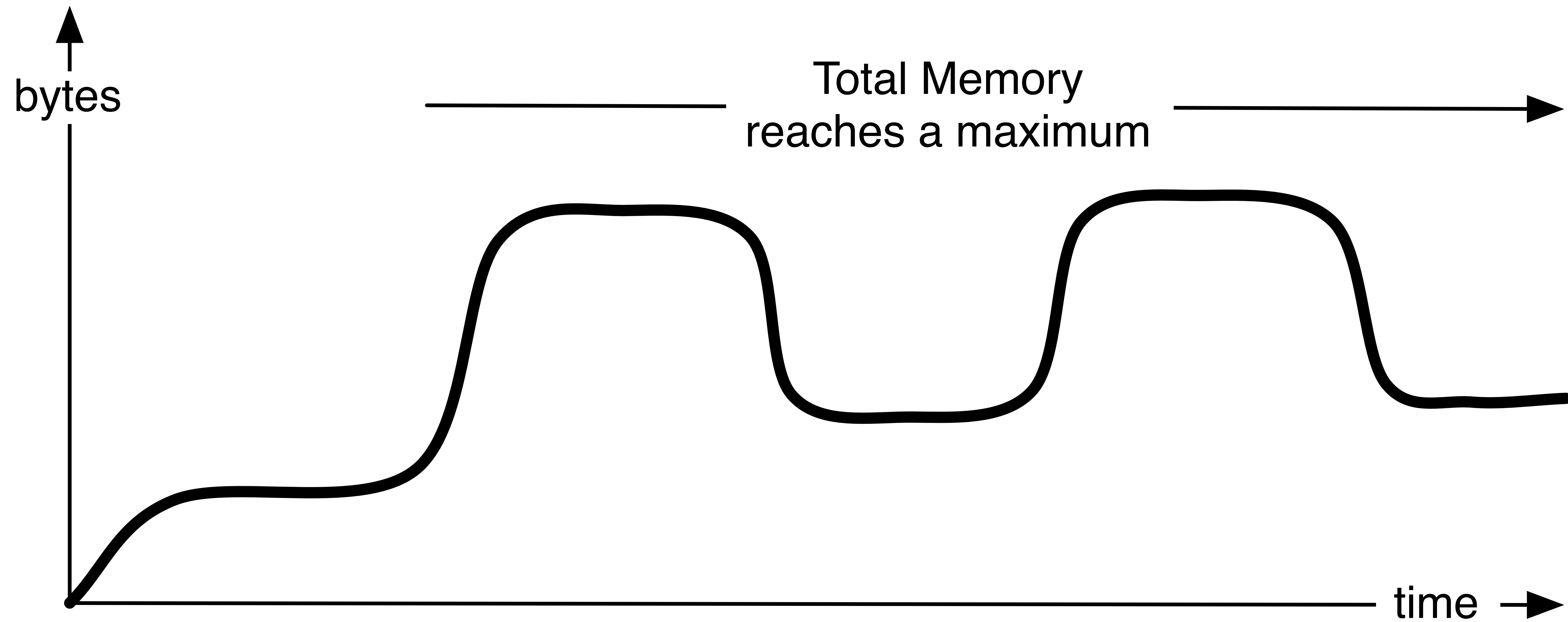
Without Memory Leaks



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The Usual Suspects

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- **Array**

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The Usual Suspects

- Array
- Object used as map

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The Usual Suspects

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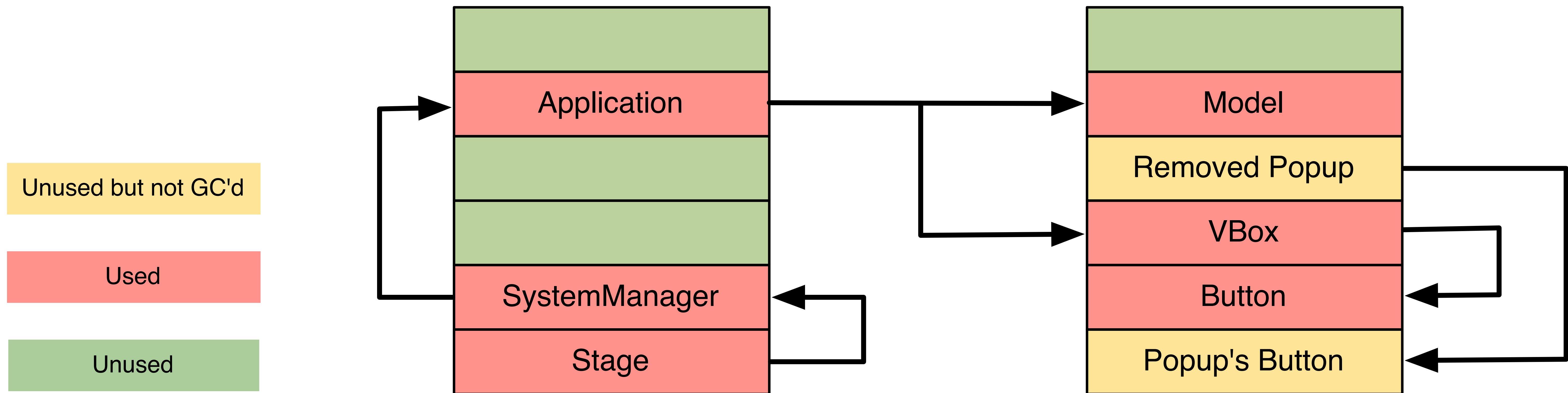
The Usual Suspects

- Array
- Object used as map
- Dictionary with strong references
- Failure to remove event listeners

How Garbage Collection Works?

```
<mx:Application>
    <mx:Model id="model"/>
    <mx:VBox>
        <mx:Button/>
    ...
</mx:Application>
```



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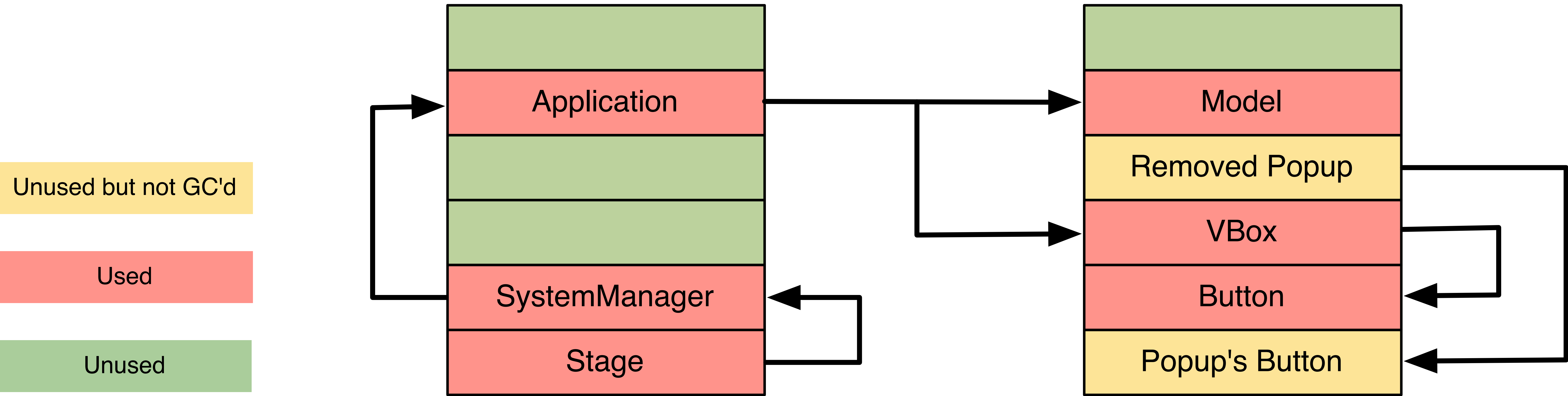
- **GC starts at the roots of objects trees**



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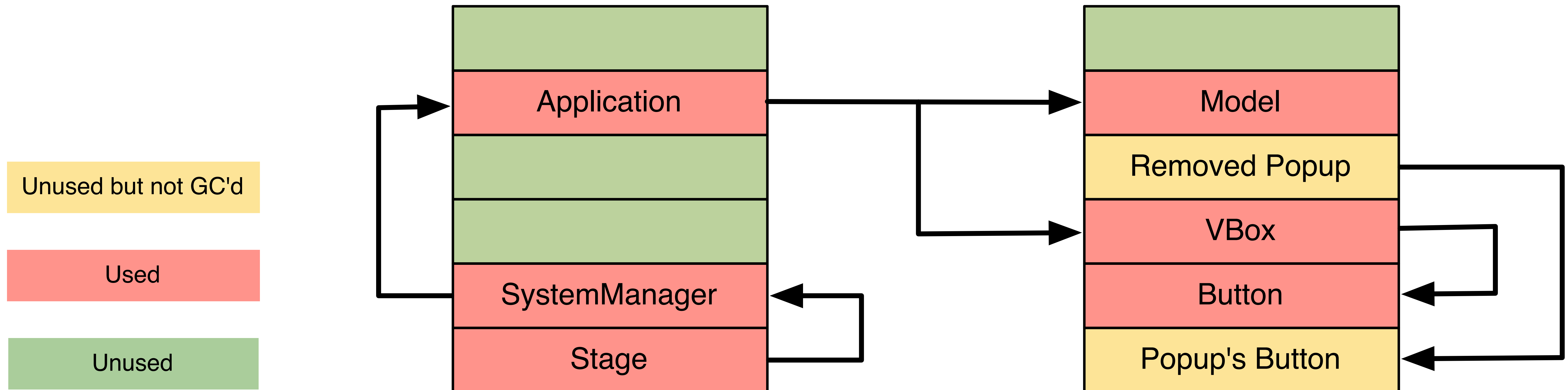
- **GC starts at the roots of objects trees**
- **marks them and all objects they refer to**



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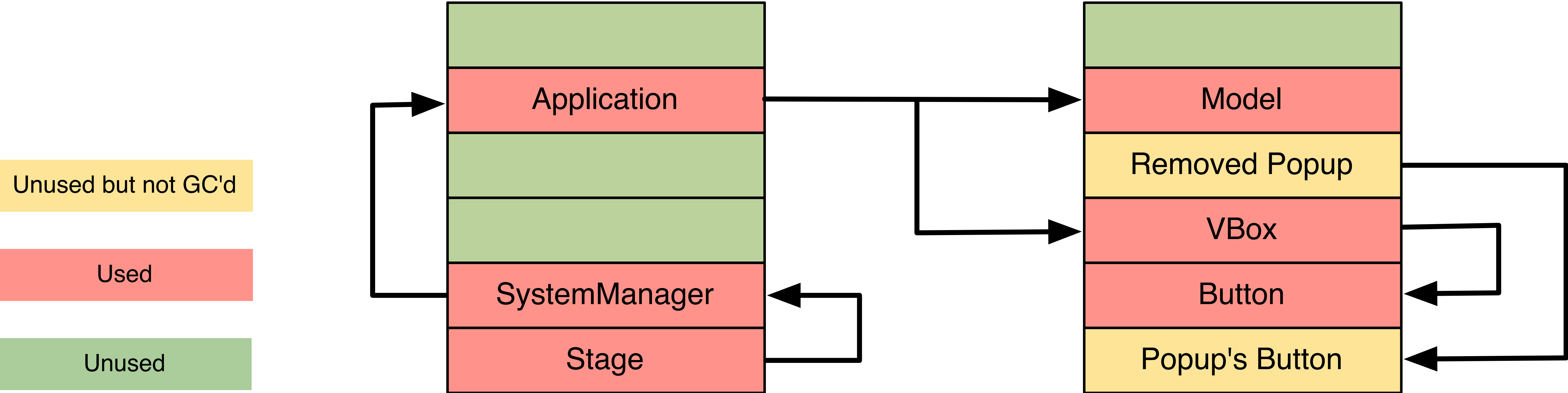

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- GC starts at the roots of objects trees
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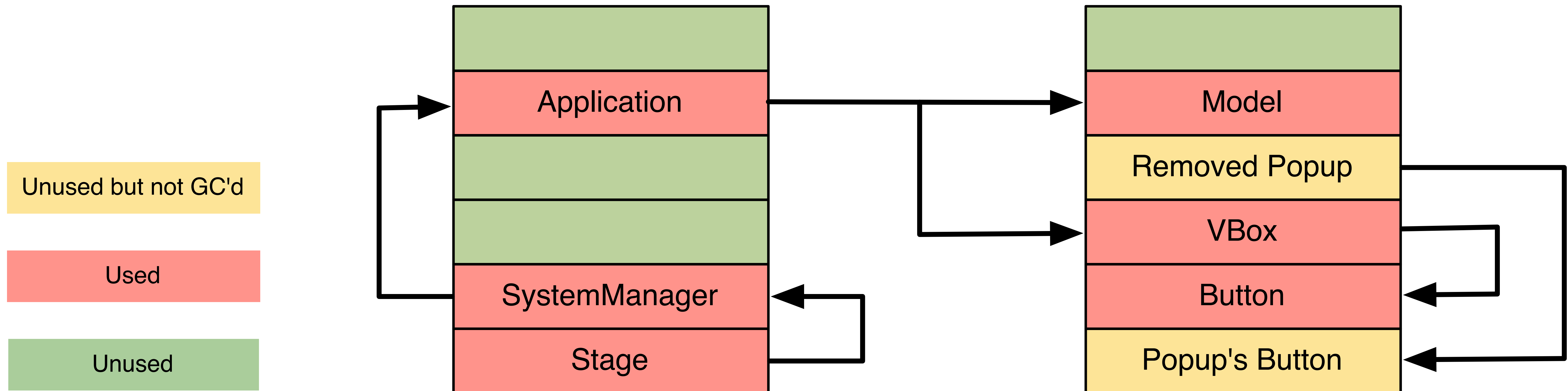
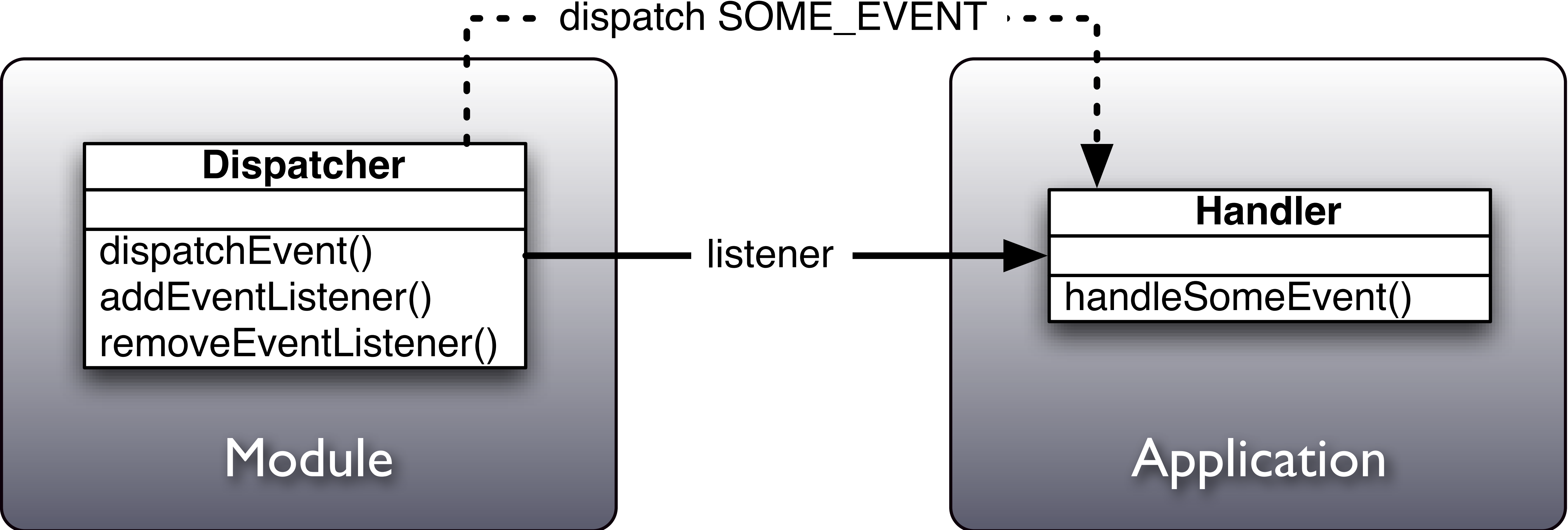
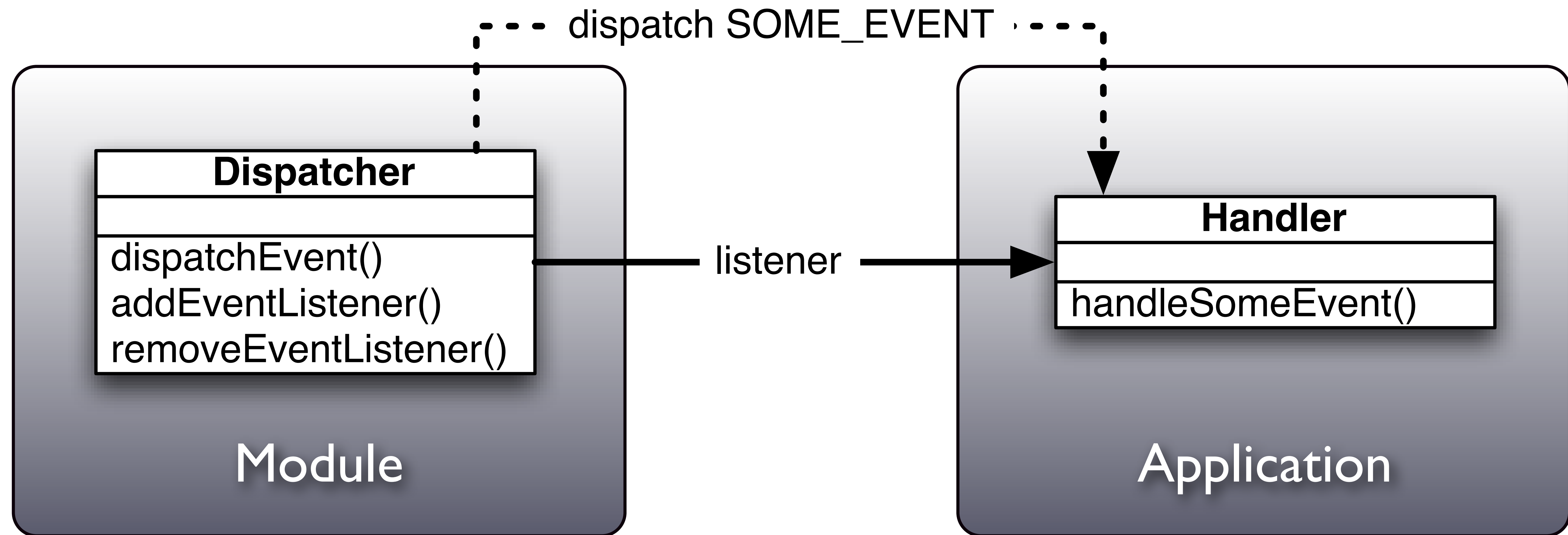
- then go through the heap and free unmarked objects
- top objects are ApplicationDomain, Stage, Stack for local variables



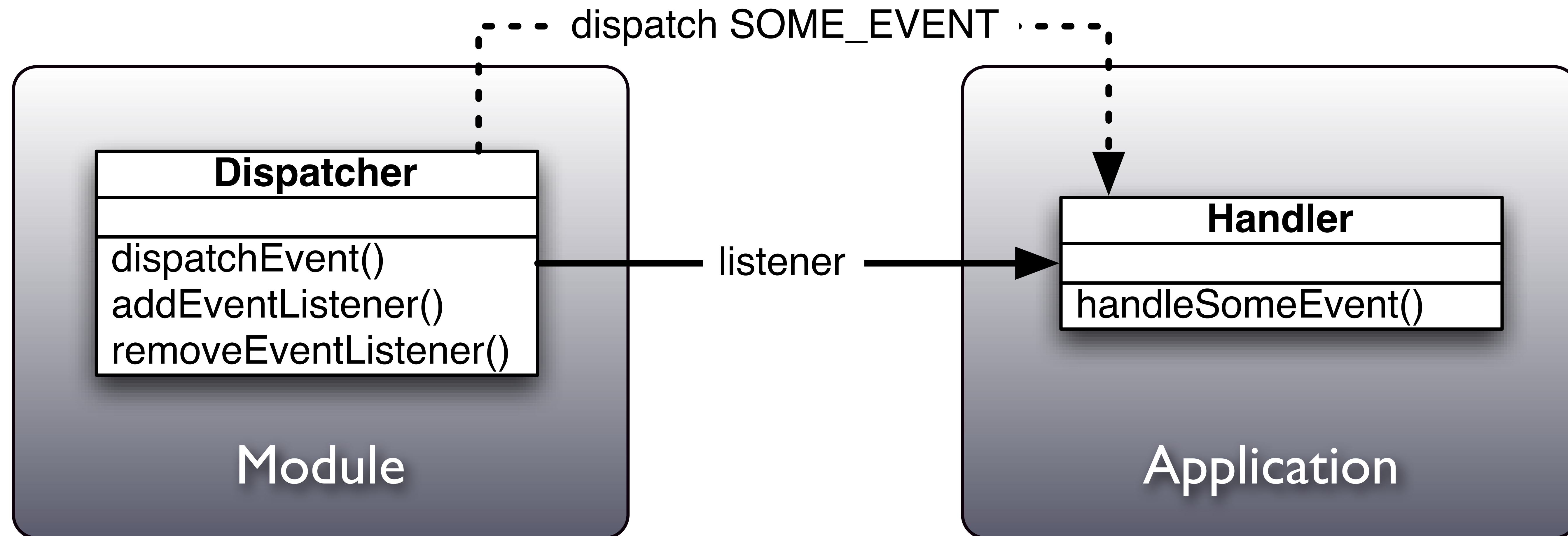
Removing Event Listeners


dispatch SOME_EVENT
Dispatcher
dispatchEvent()
addEventListener()
removeEventListener()
listener
Handler
handleSomeEvent()
Module
Application

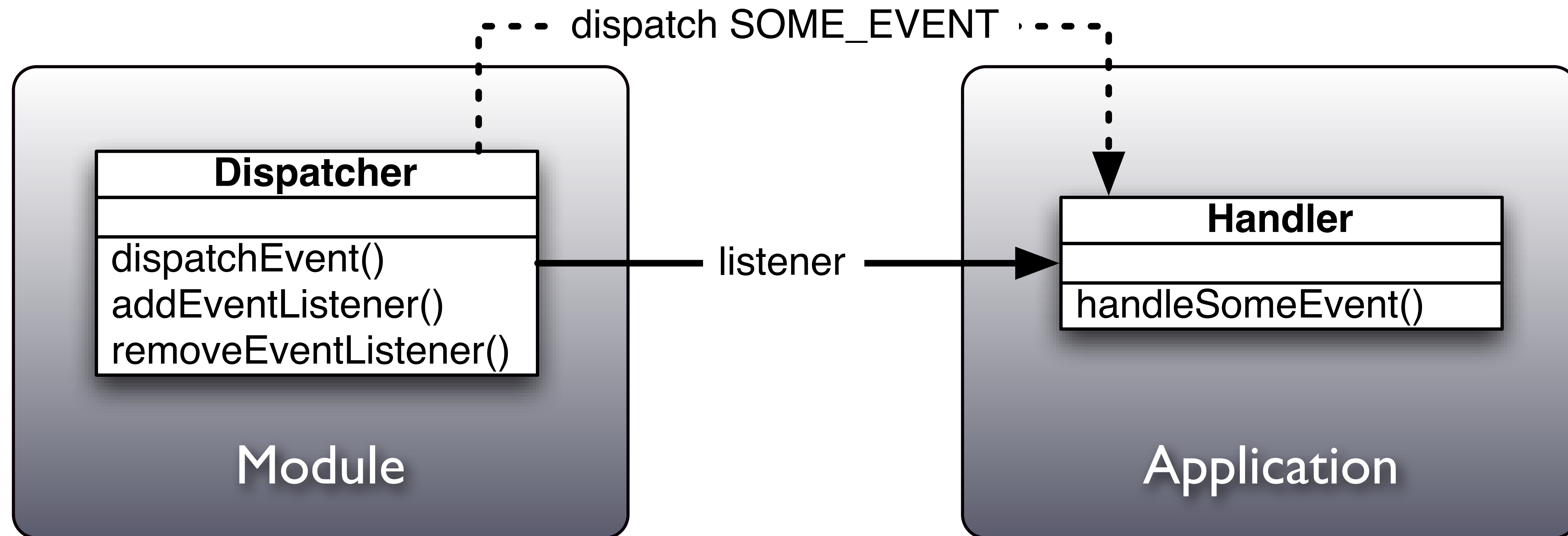
Child



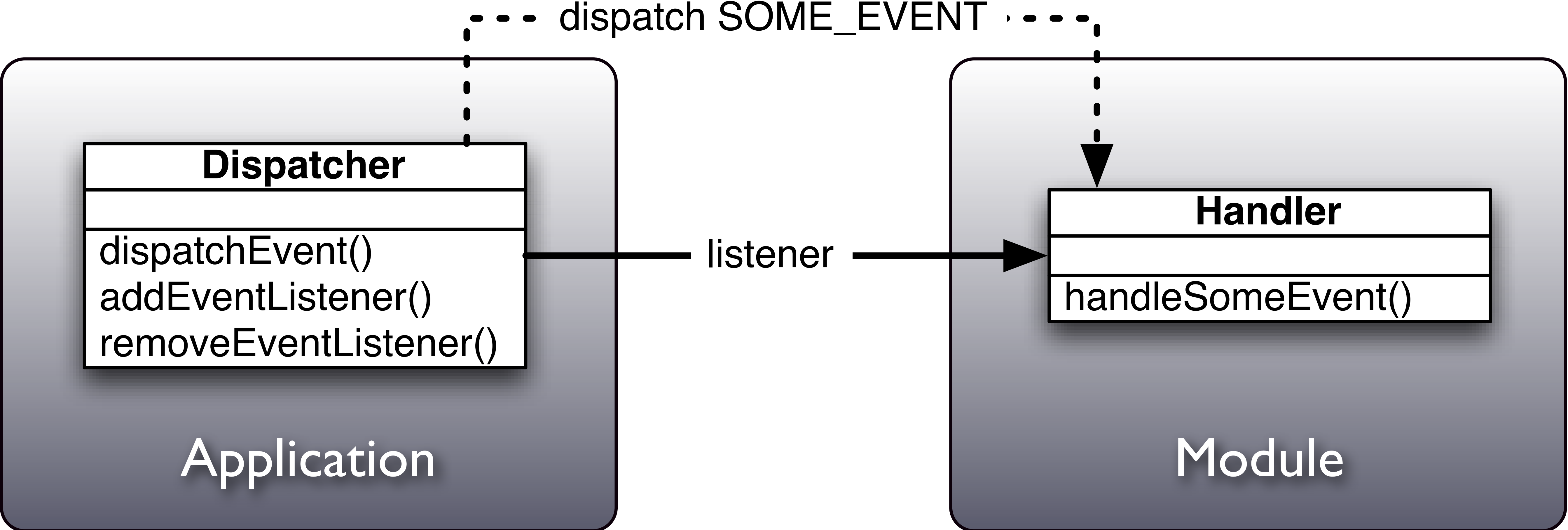
Child Parent



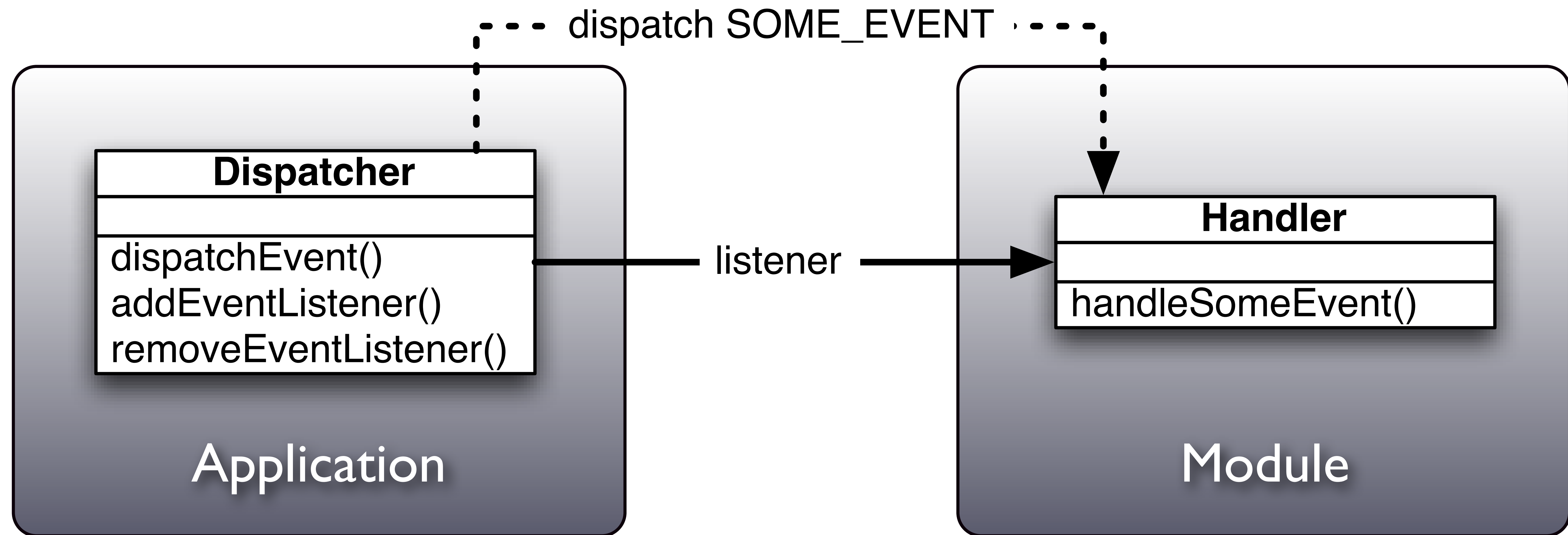
Child **Parent**



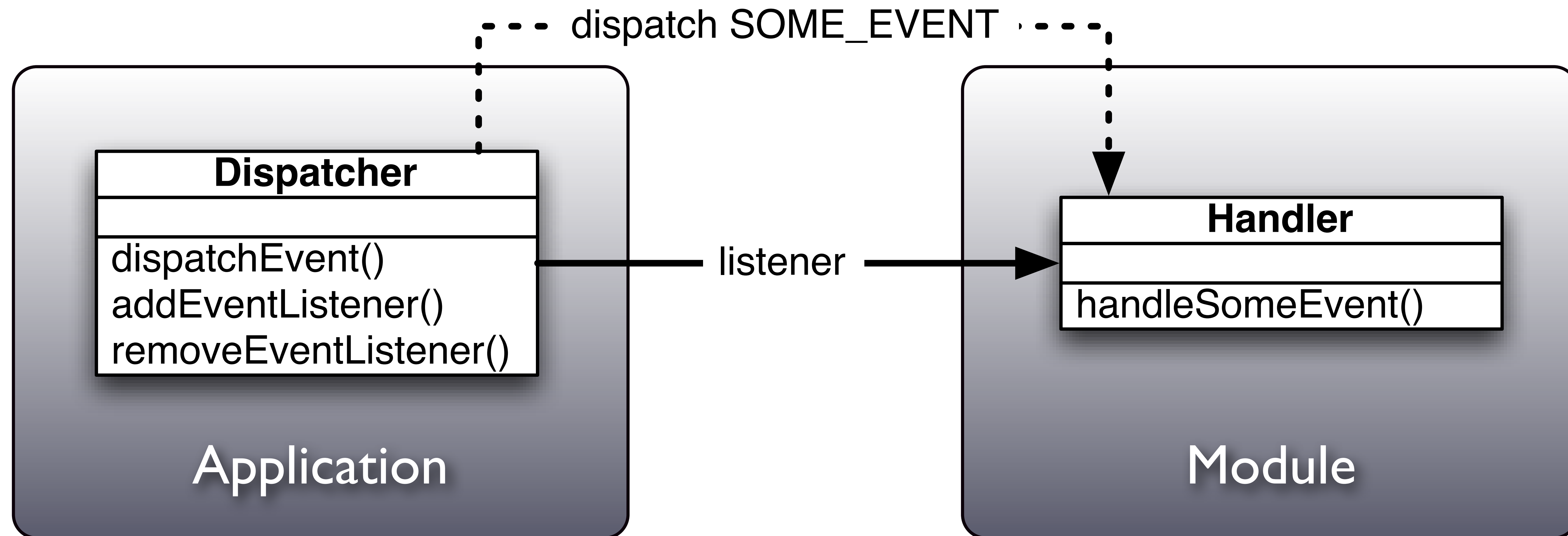
doesn't cause memory leak - it is not necessary to remove the event listener


dispatch SOME_EVENT
Dispatcher
dispatchEvent()
addEventListener()
removeEventListener()
listener
Handler
handleSomeEvent()
Application
Module

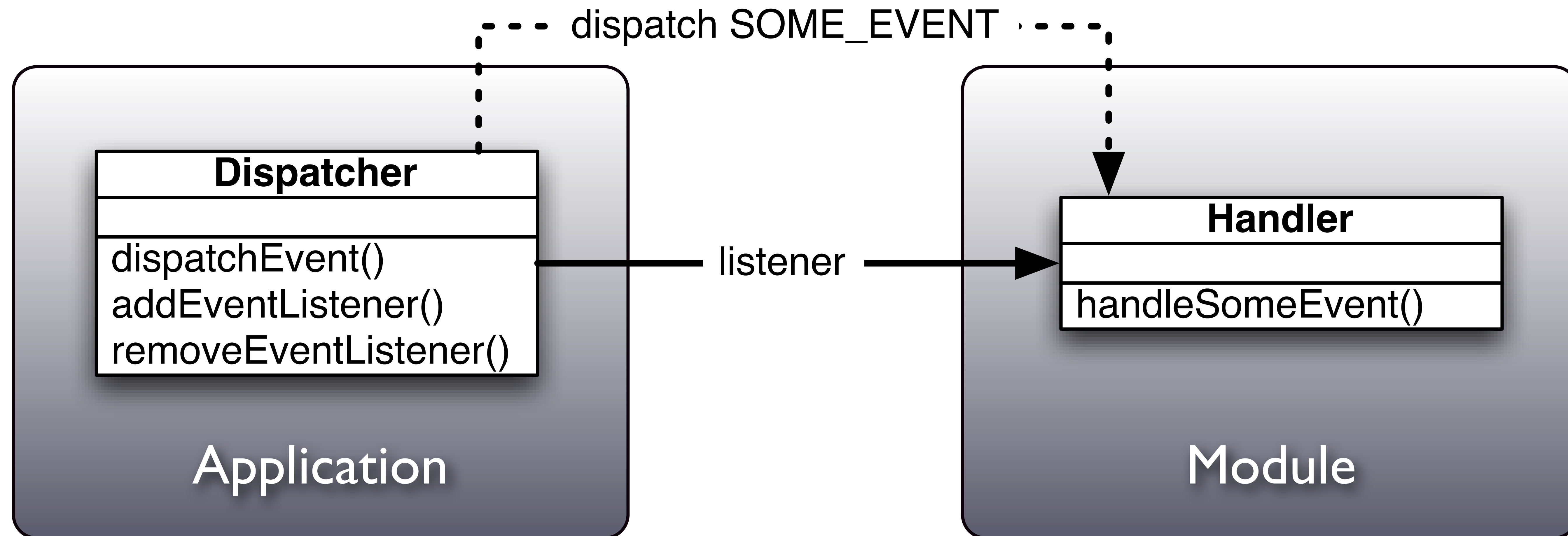
Parent



Parent | Child



Parent   Child



causes memory leak - the application keeps referencing the Module - event listener needs to be removed or use weak reference

Reuse Objects

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- thus you can reuse renderers just like the List components reuses its items

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…or use *Loader.unloadAndStop()* (only in Flash 10)

Optimization Rules of Thumb

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- use *vector*<> instead Array (only in Flash 10)

Other optimization techniques

the fastest way to copy an Array

```
var copy : Array = sourceArray.concat();
```

use integers for iterations

```
for (var i : int = 0; i < n; i++)
/* not */
for (var i : Number = 0; i < n; i++)
```

Multiply vs. Divide

```
5000 * 0.001
/* instead of */
5000 / 1000
```

```
comp.setStyle(“color”, 0xff00ff);
```

avoid the setStyle method - one of the most expensive calls in the framework

```
<mx:Panel>
    <mx:VBox>
        <mx:HBox>
            <mx:Label text="Label 1"/>
             <mx:VBox>
                  <mx:Label text="Label 2"/>
              </mx:VBox>
              <mx:HBox>
                  <mx:Label text="Label 3"/>
                  <mx:VBox>
                      <mx:Label text="Label 4"/>
                  </mx:VBox>
              </mx:HBox>
          </mx:HBox>
      </mx:VBox>
</mx:Panel>
```

too many nested containers dramatically reduces the performance

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- use the Flex SDK *optimizer* tool

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- how GC works
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- how GC works
- removing event dispatchers
- various optimization techniques