V8 Garbage Collection

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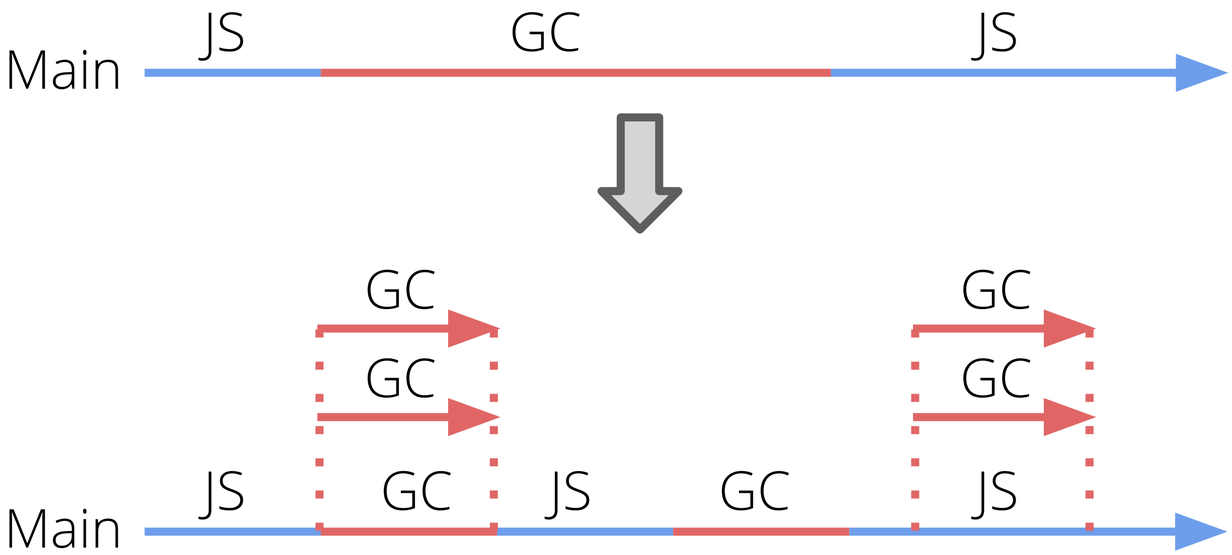
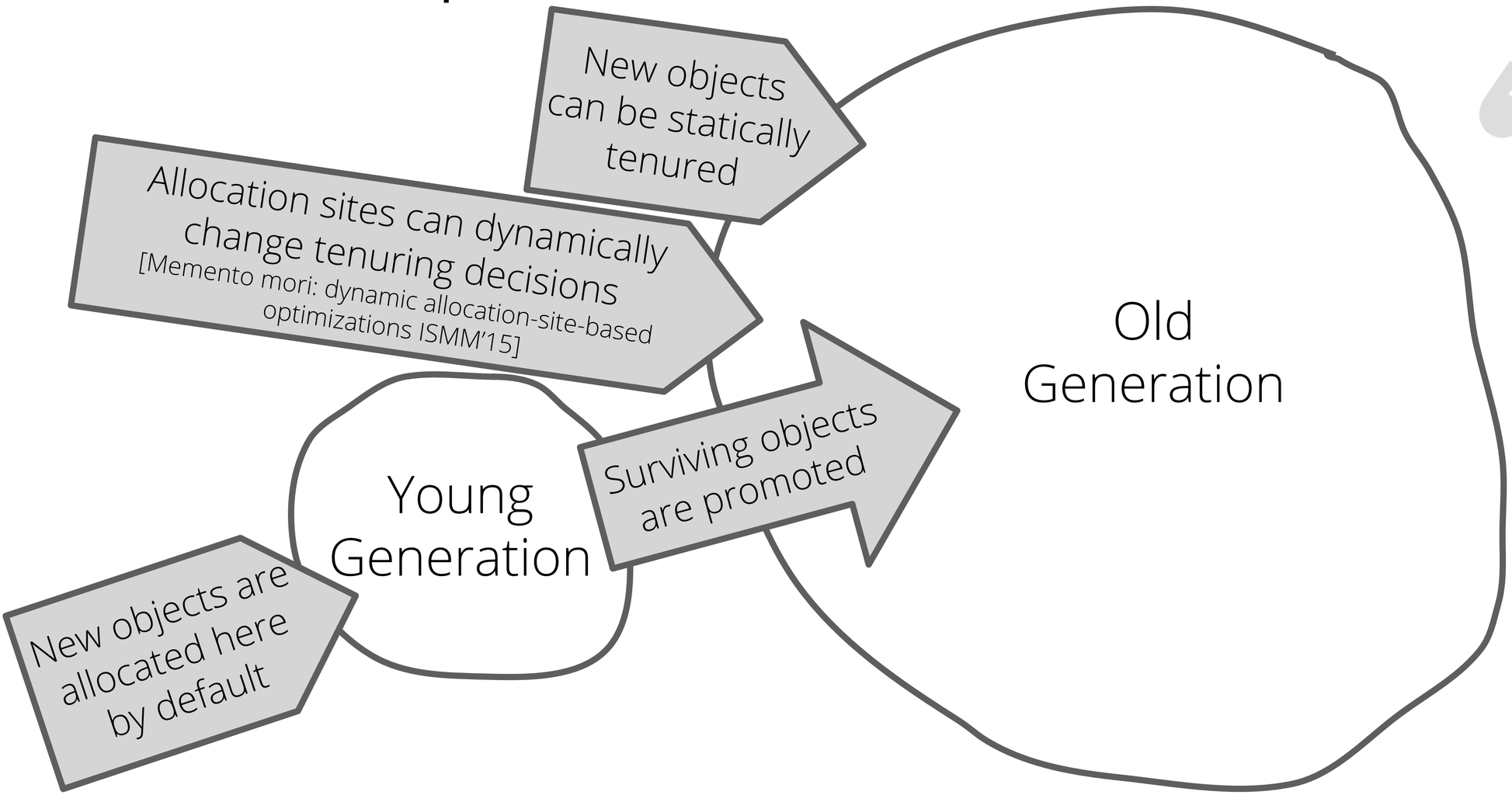
Google|Chrome|V8
https://research.google.com/pubs/HannesPayer.html

V8 Orinoco

A generational, moving, mostly parallel and concurrent garbage collector with incremental fallback.



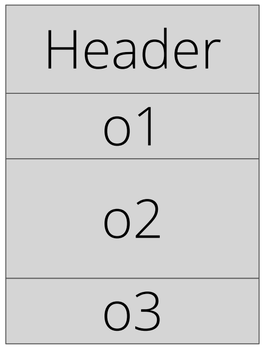
V8 Heap Architecture



"Most objects will die young."

V8 Heap Architecture

Regular Pages



- 256K right now
- Meta-data page header: marking bitmap, remembered set, etc.
- Fast page lookup mechanism from objects
- Page-based parallelization

Large Objects

- Arbitrary size
- Young or old generation
- Slow page lookup mechanism from within large objects

V8 Orinoco Features

Young Generation GC

- Up to 16M
- Semi-space
- Parallel Scavenger
- Alternative minor Mark-Compact --minor-mc

Full GC

- Old & Young Generation
- Concurrent, parallel & incremental marking
- Concurrent, parallel & incremental sweeping
- Parallel compaction

Young Generation Garbage Collector

Scavenger

- Single-pass over the young generation
- Fast when most objects die young
- Slow when many objects survive (99%tile)

Minor Mark-Compact

- Two passes over the young generation
- Copy-free promotion
- Too slow on the common cases
- Faster on the higher %tiles

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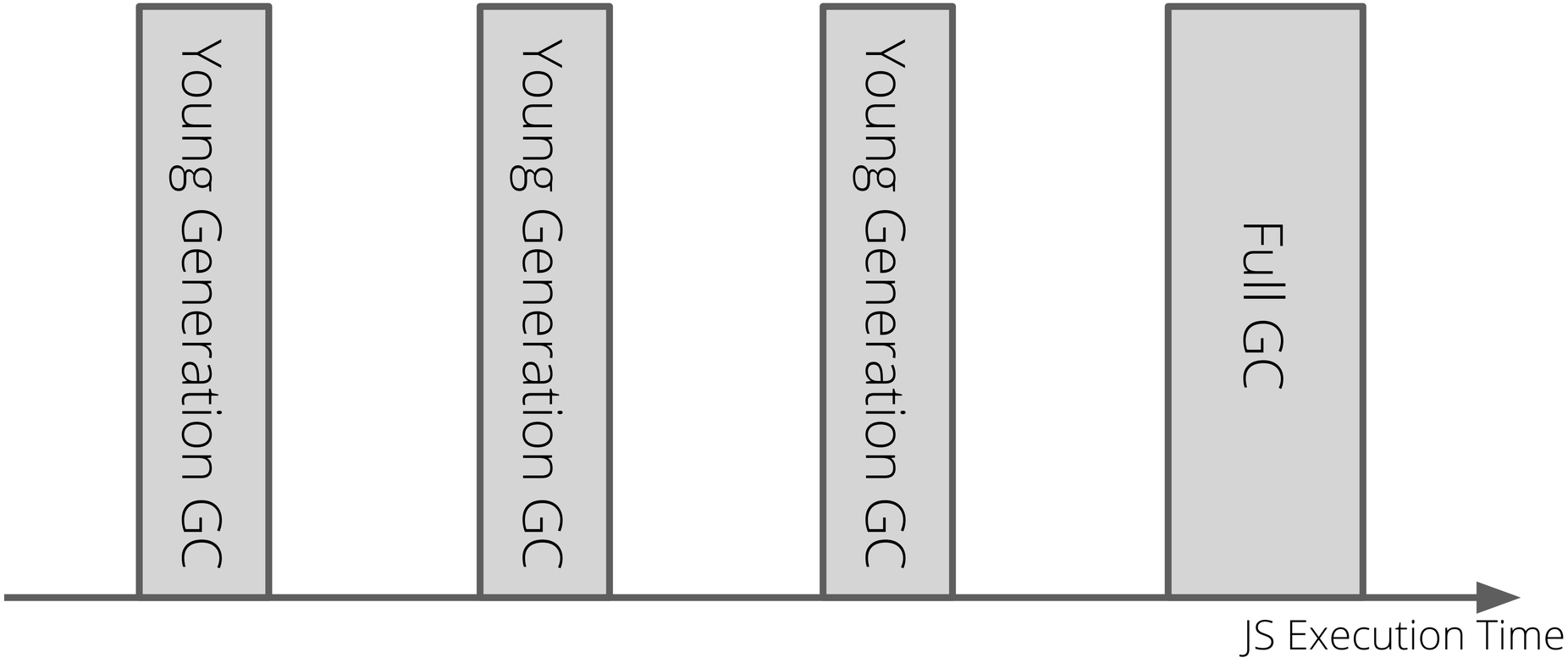
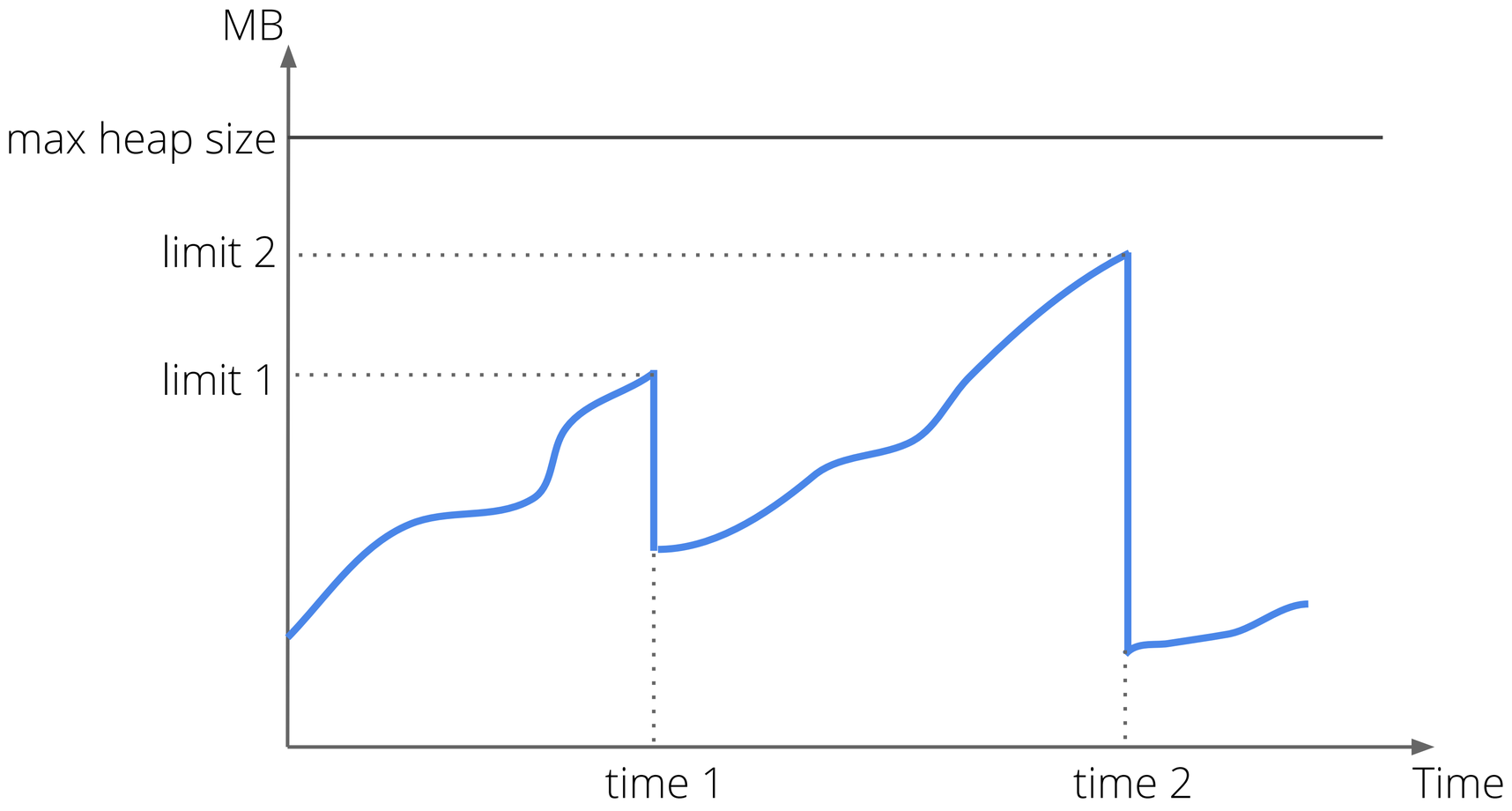
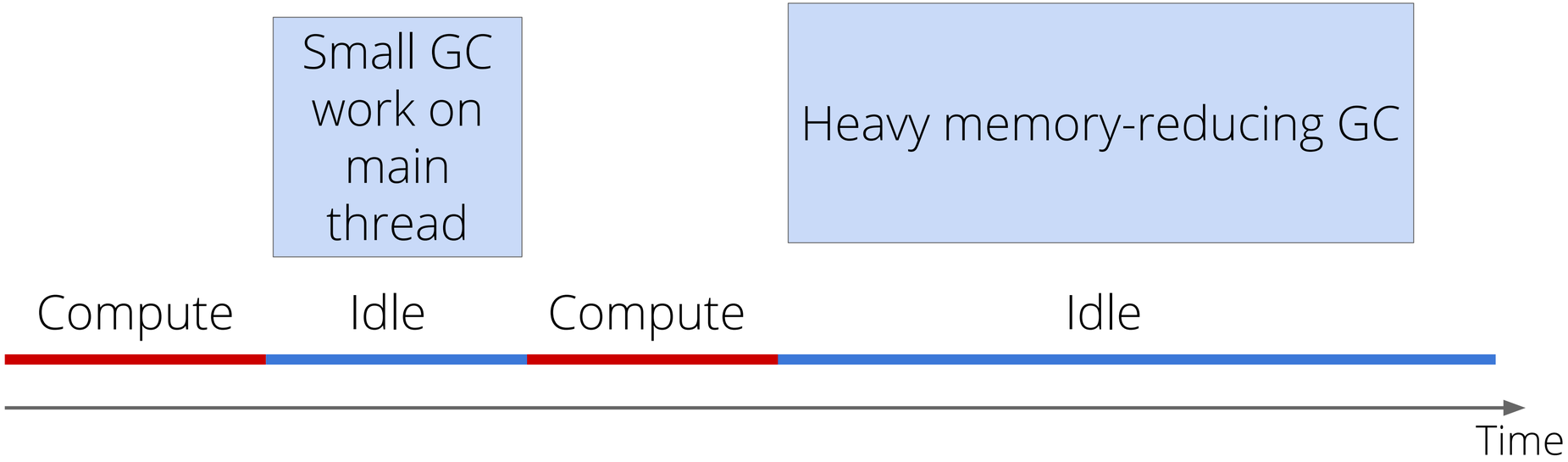
V8 Garbage Collection Events



Garbage Collection Scheduling

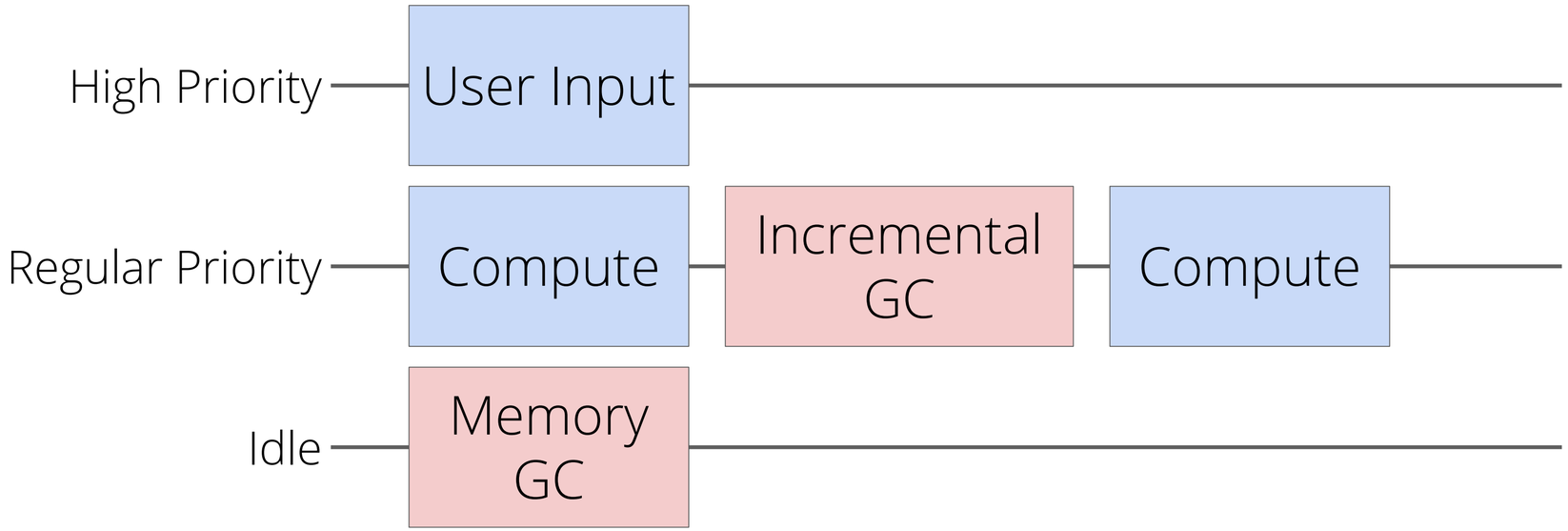


Garbage Collection Scheduling



Idle Time Garbage Collection Scheduling
[PLDI'16, Communications ACM 59(10)]

Garbage Collection Scheduling



Priority queues of the main thread task scheduler

Reduce Queuing time of tasks.

Concurrent Marking is a solved problem!

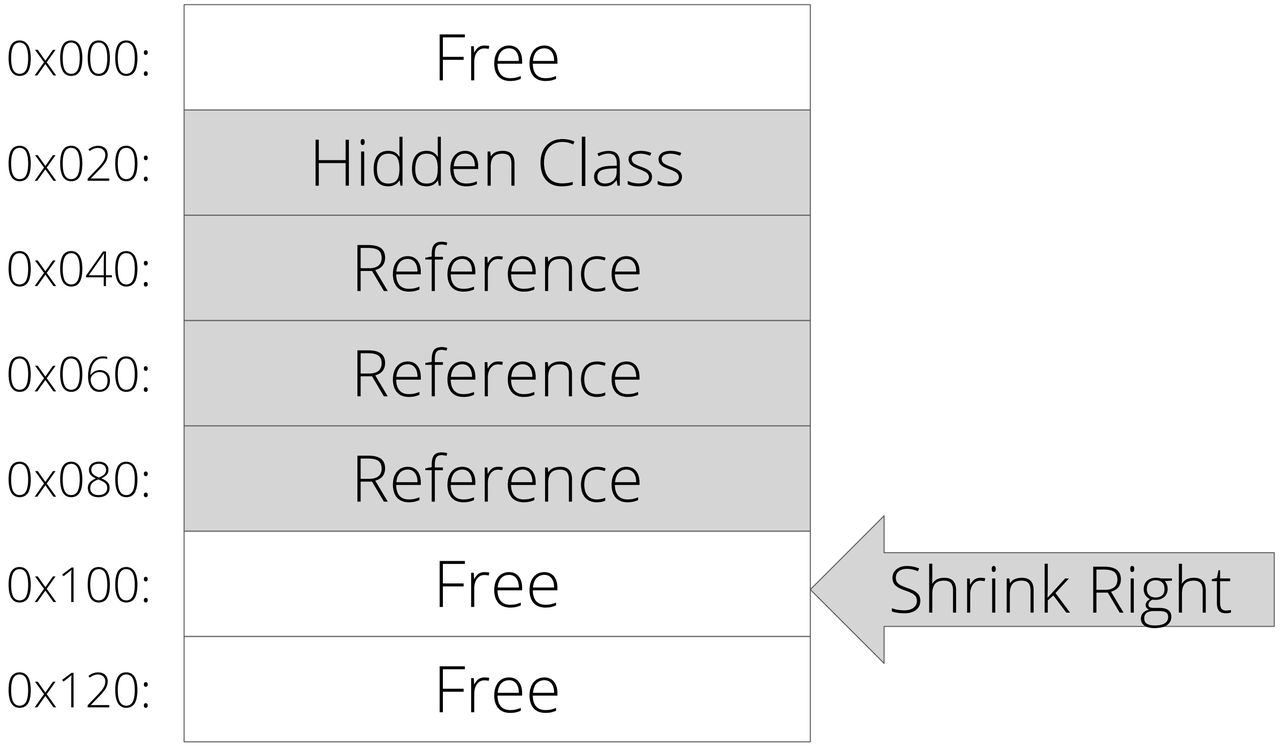
Really!?

Concurrent Marking of Shape-Changing Objects

0x000:	Free
0x020:	Hidden Class
0x040:	Reference
0x060:	Reference
0x080:	Reference
0x100:	Reference
0x120:	Free

Concurrent Marking of Shape-Changing Objects [ISMM'19]

Concurrent Marking of Shape-Changing Objects



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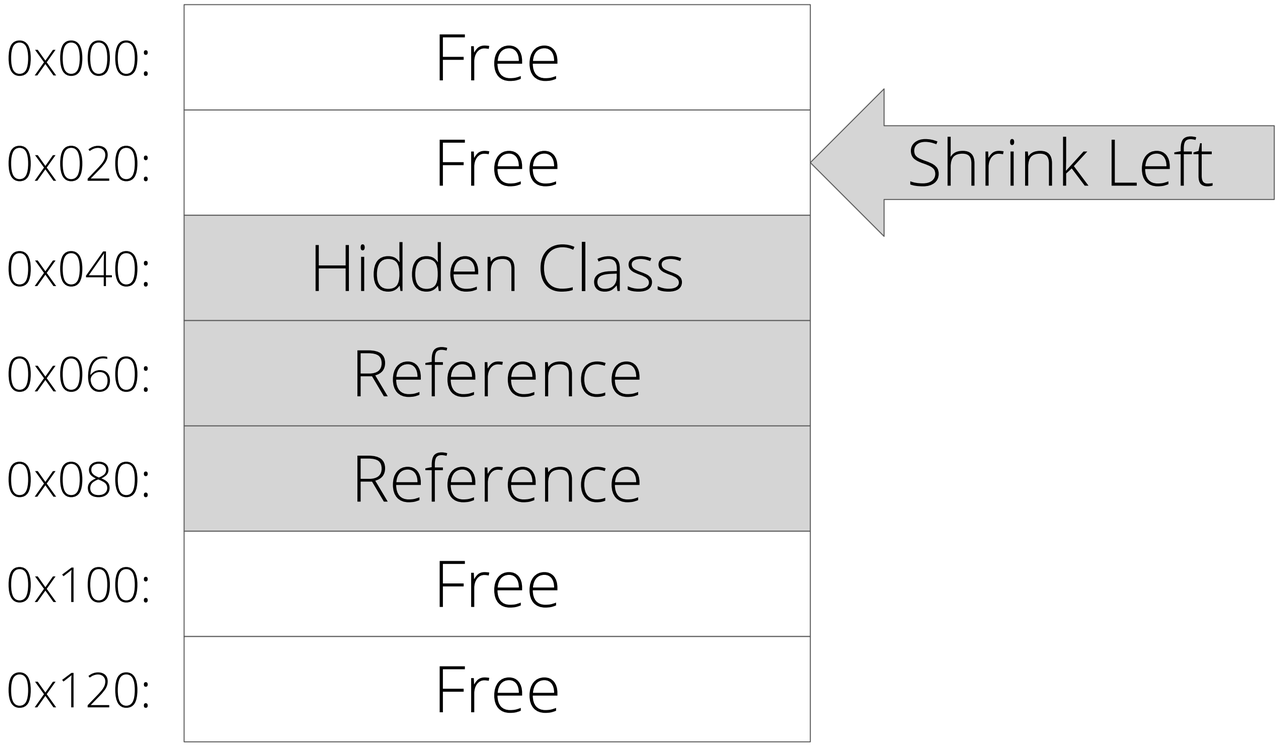

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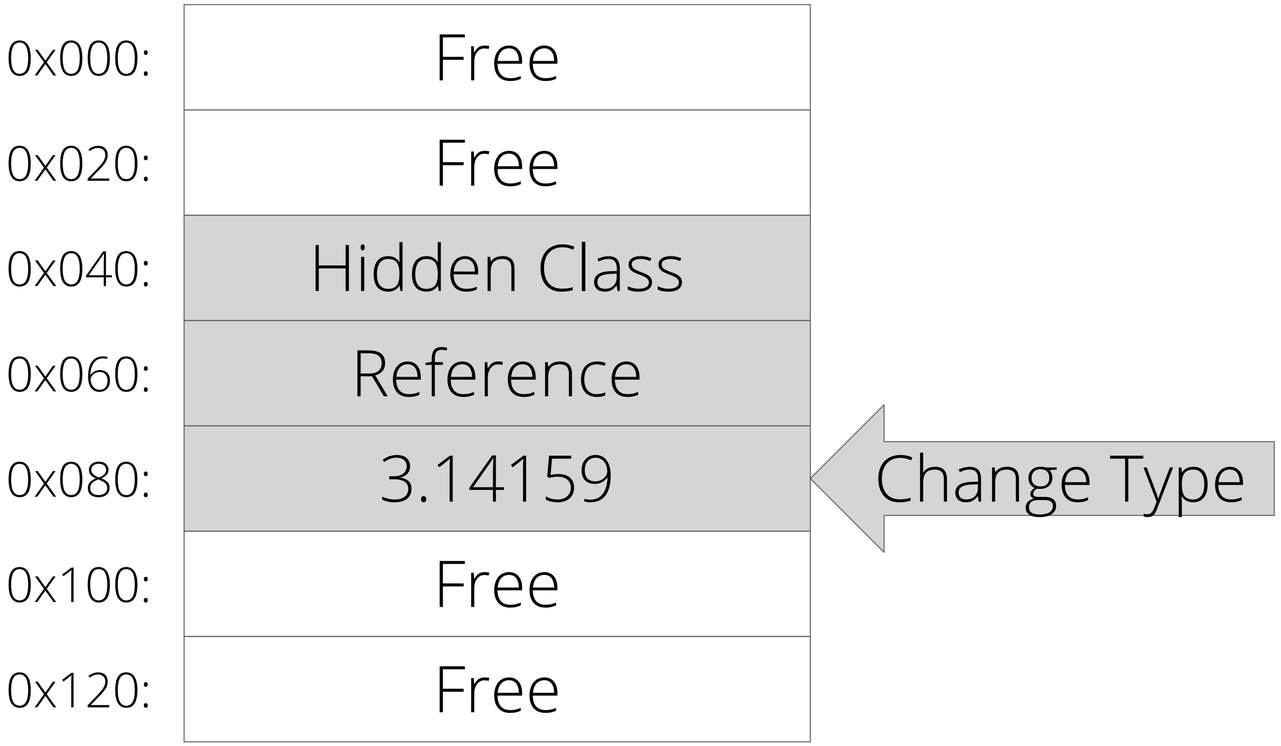

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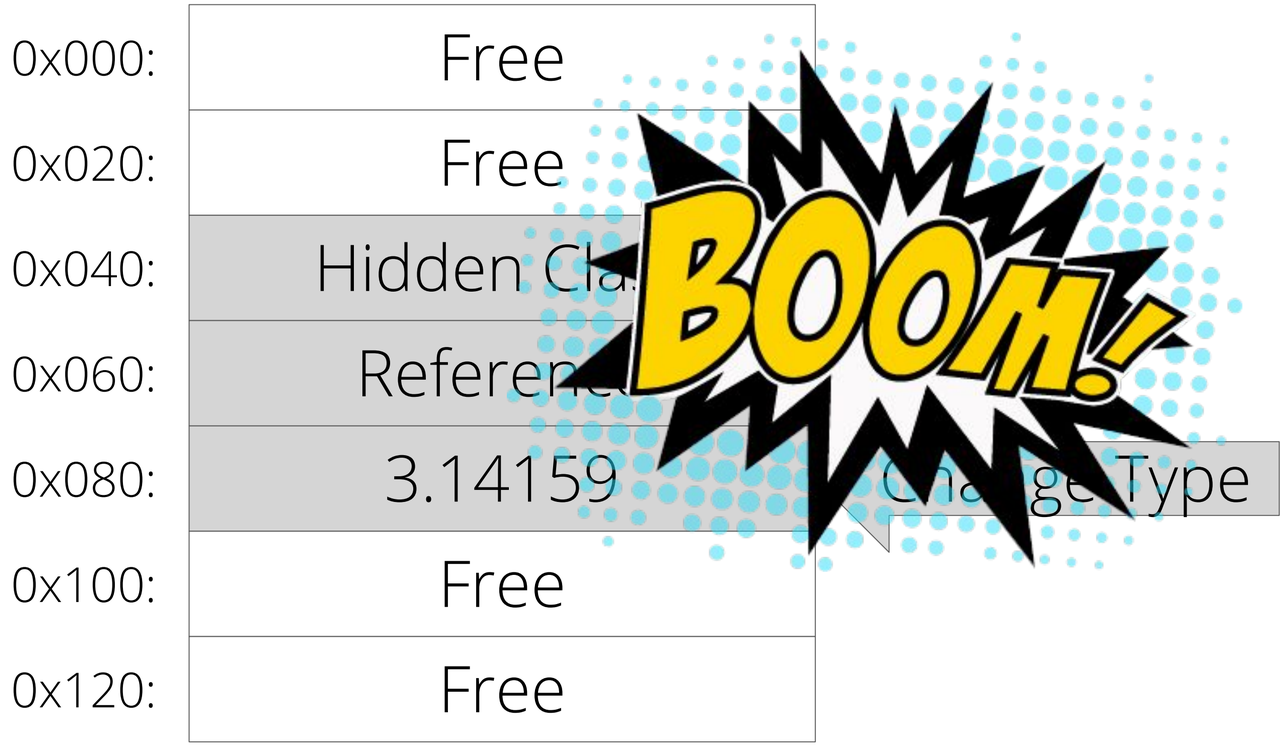

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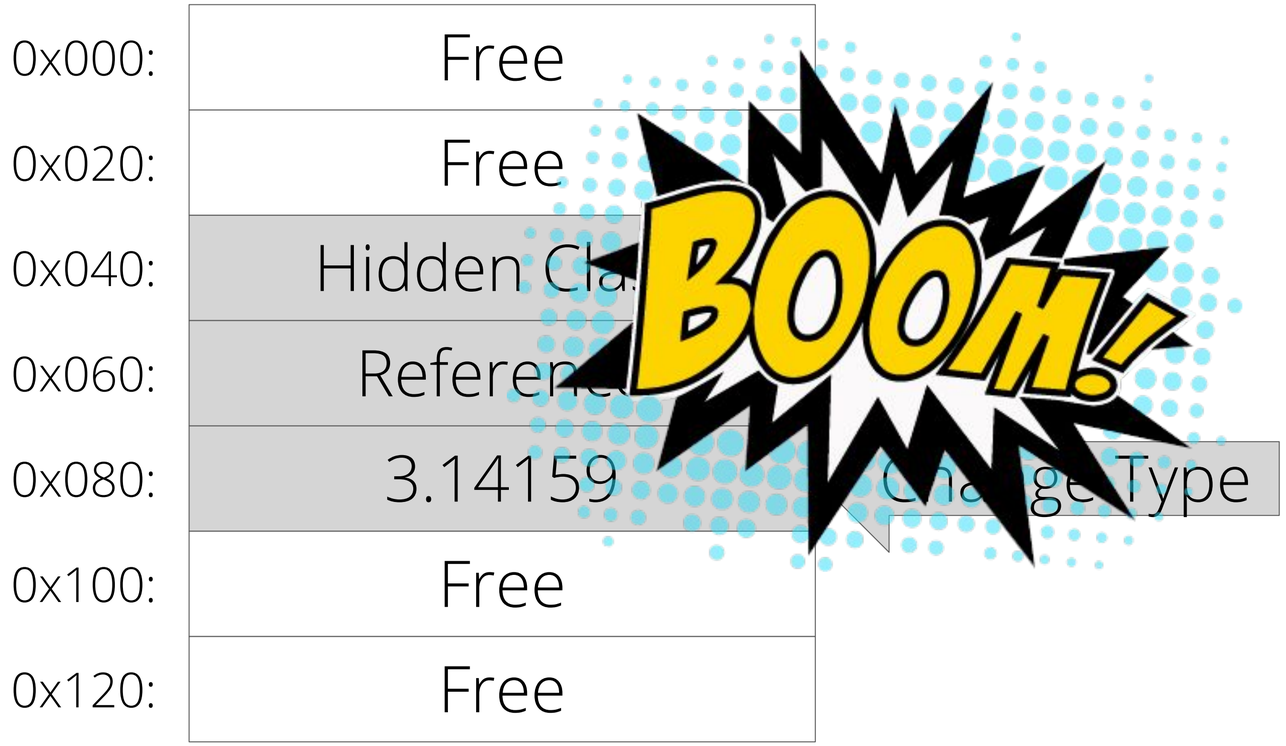


Tomorrow 14:45 - 15:15
Room 106A

Concurrent Marking of Shape-Changing Objects [ISMM'19]

Heap/Garbage Collector Interface

1. Memory allocator: Bump-pointer

2. Write Barriers:
   - Old to young generation objects
   - References that point to objects which may be compacted
   - Marking (Dijkstra-style):

```
store obj.slot[x] = p

if (load p.color) == white:
  store p.color = grey
  push p
```

Automatically added by the Compiler and Runtime

Write Barrier Elimination: Allocation Folding Based on Dominance [ISMM'15]

Cross-Component Garbage Collection in Chrome

Blink

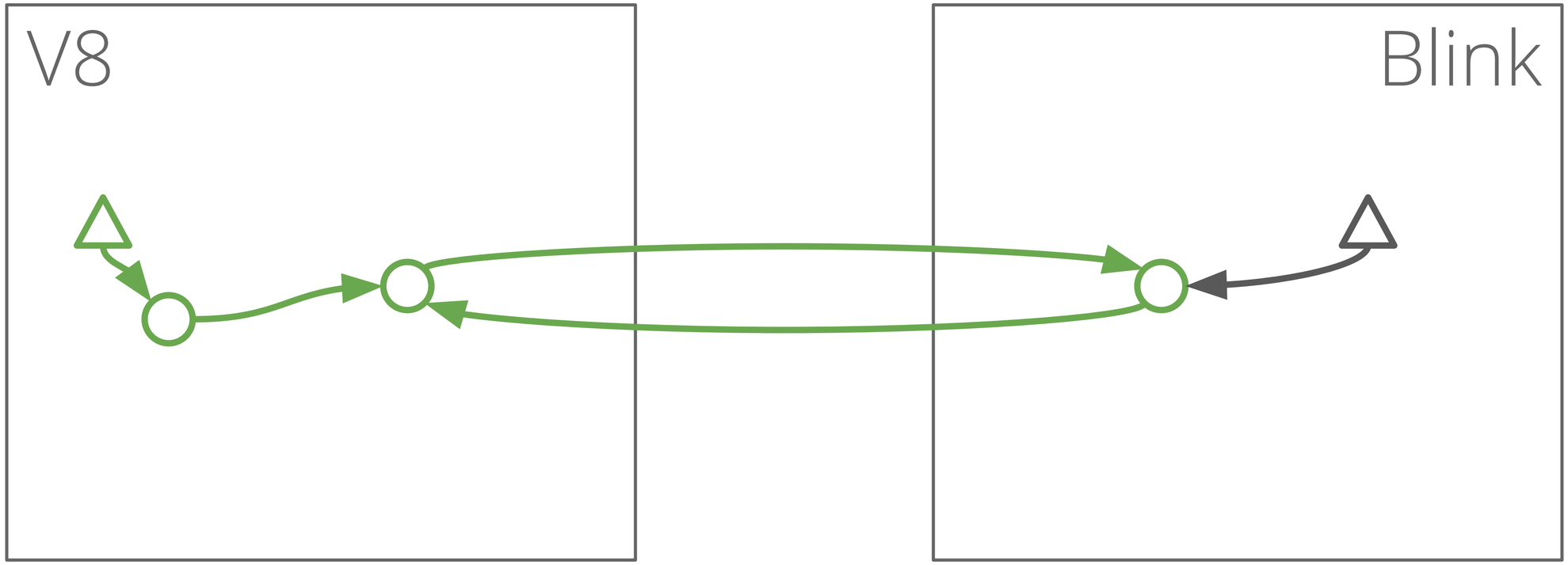
- Chrome’s web browser engine which embeds V8
- JavaScript is used to dynamically modify the DOM
- V8 objects can reference objects on the Blink heap and vice-versa
- Most of the C++ Blink heap is managed by the precise & conservative Mark-Sweep-Compact Blink garbage collector Oilpan for C++ objects

Challenge:

How do we collect the full transitive closure of objects spanning both components?

No dangling pointers

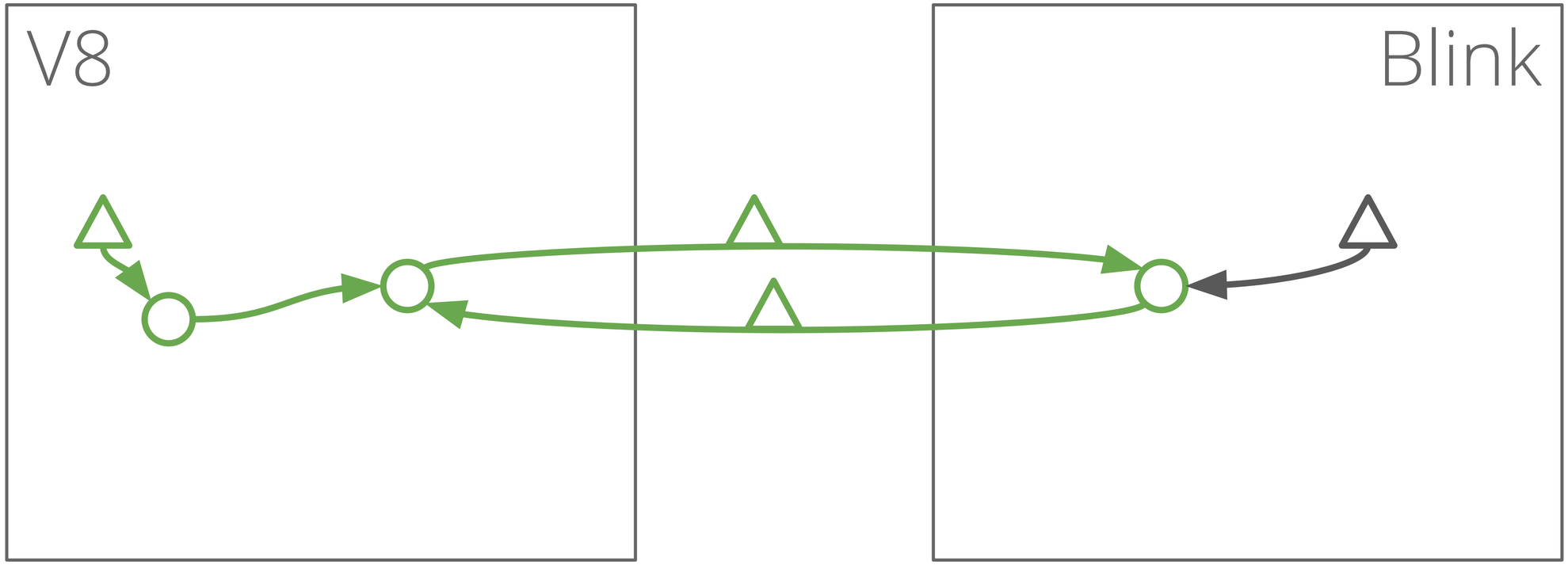
No memory leaks



Root reference

Weak reference

Traced reference



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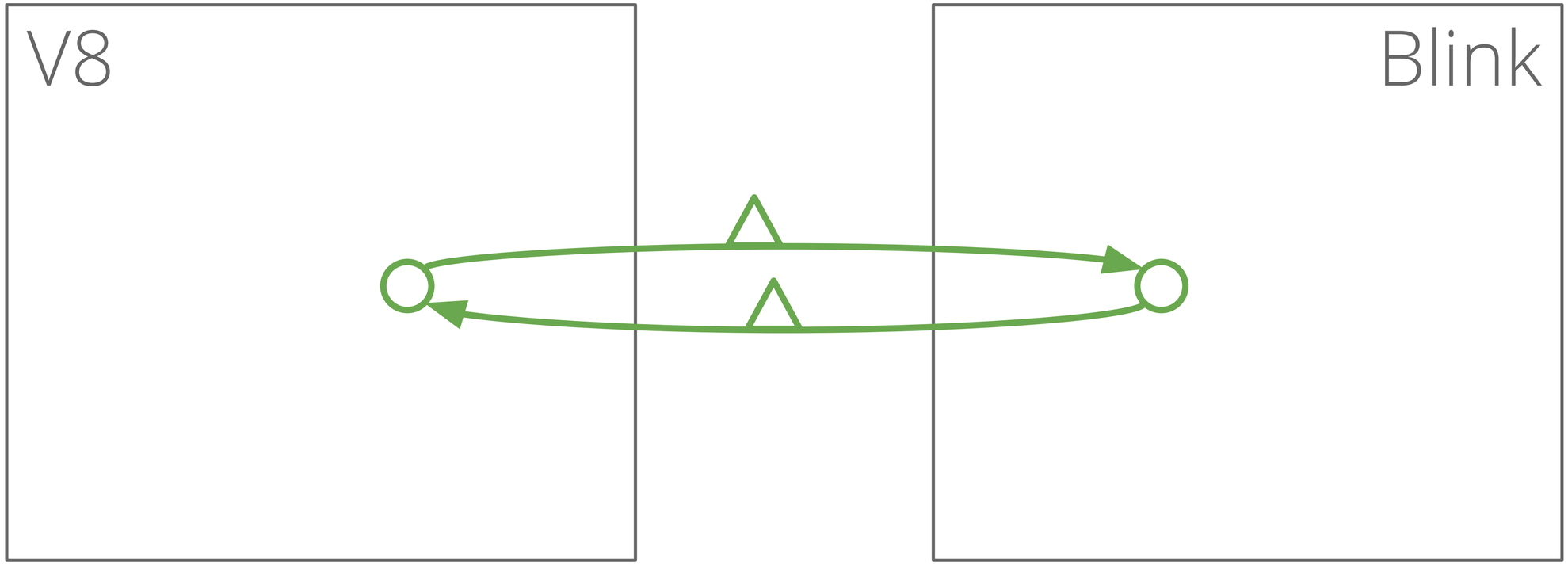

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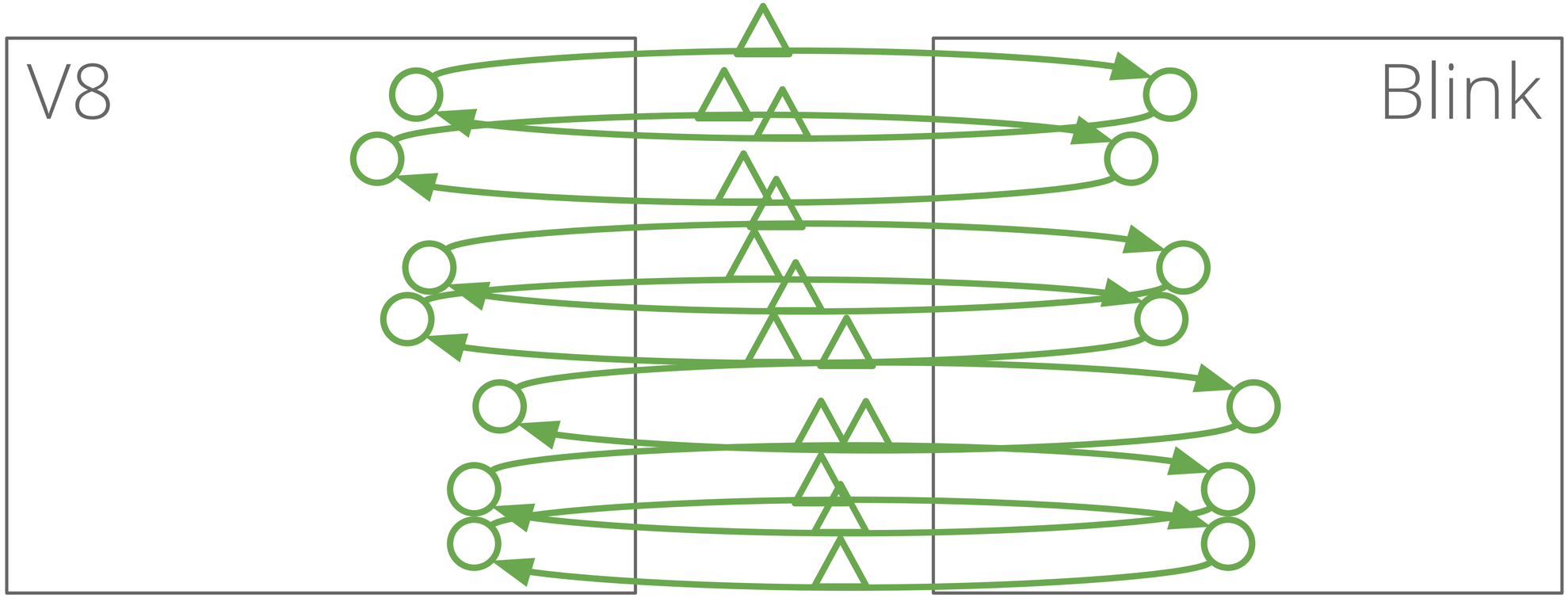

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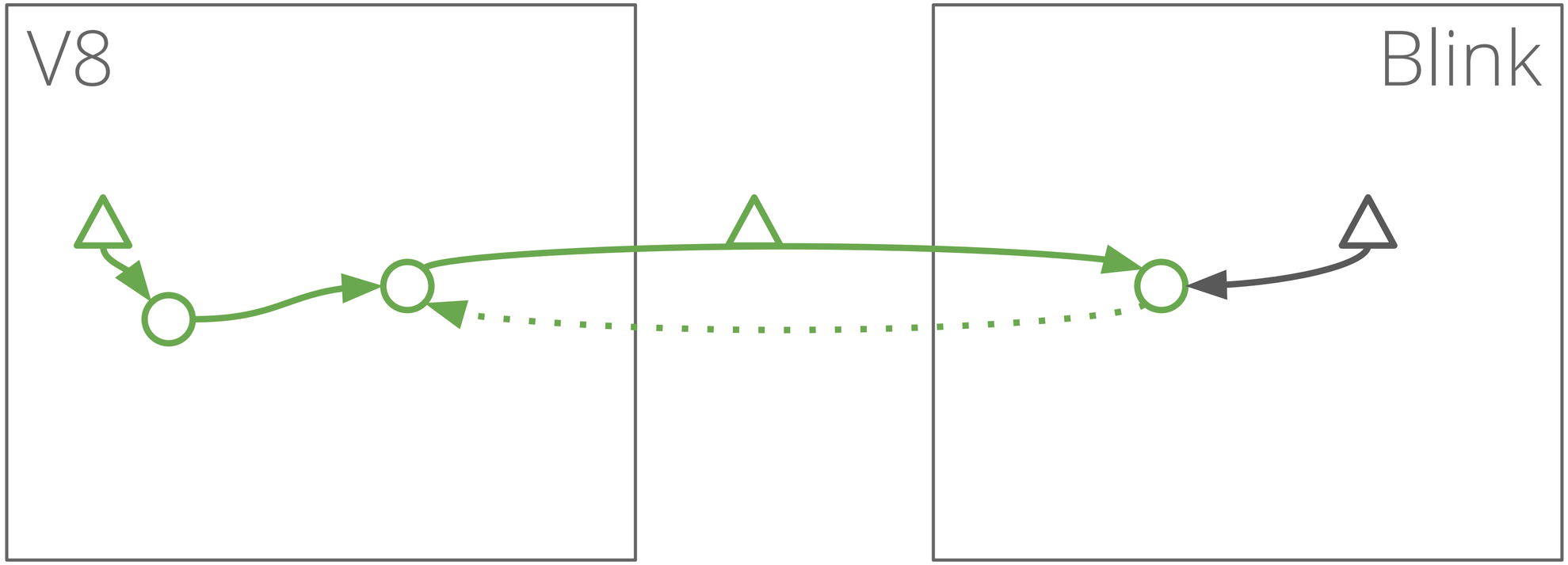

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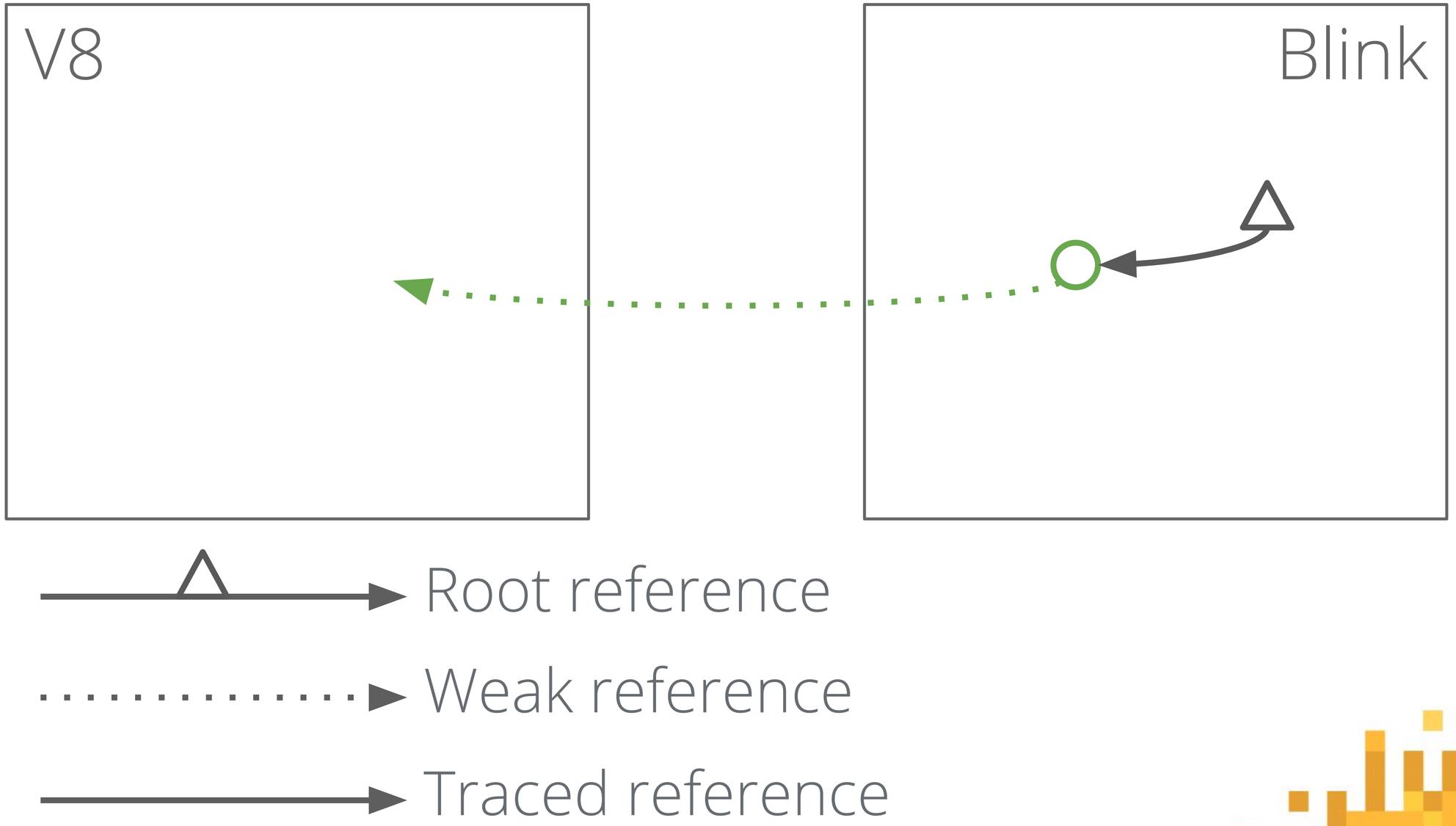
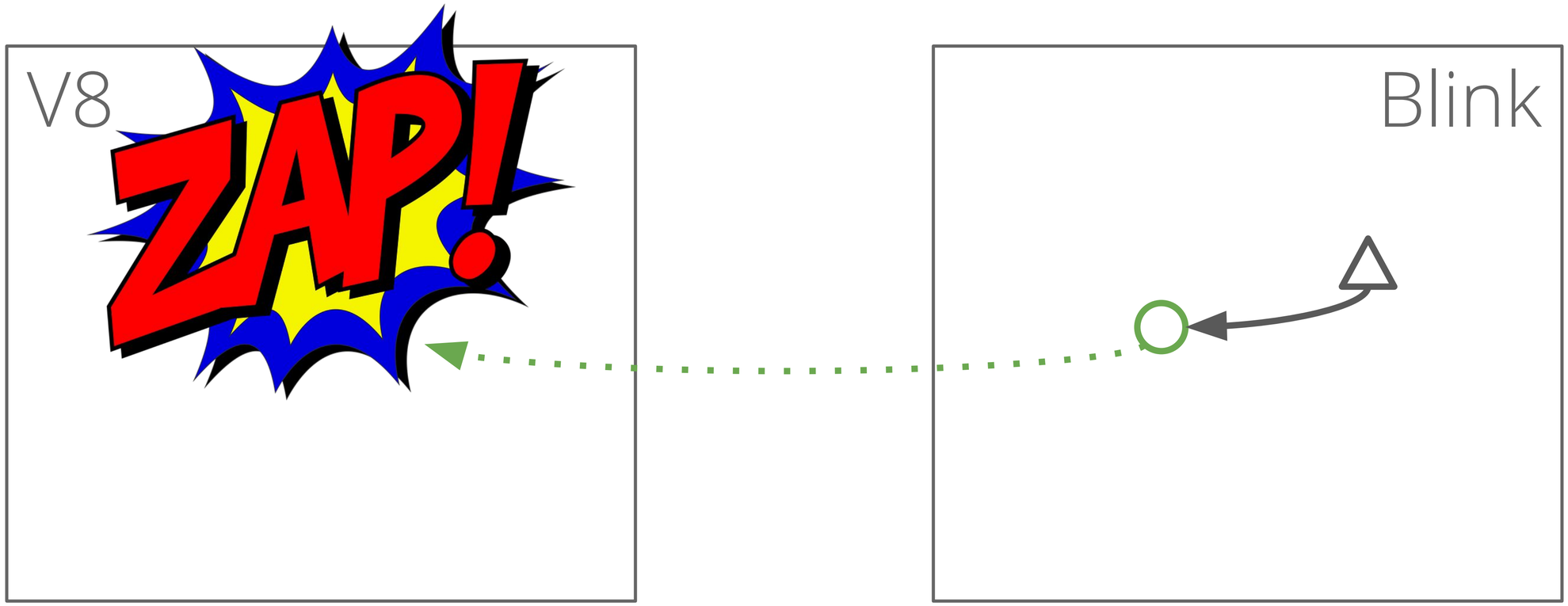
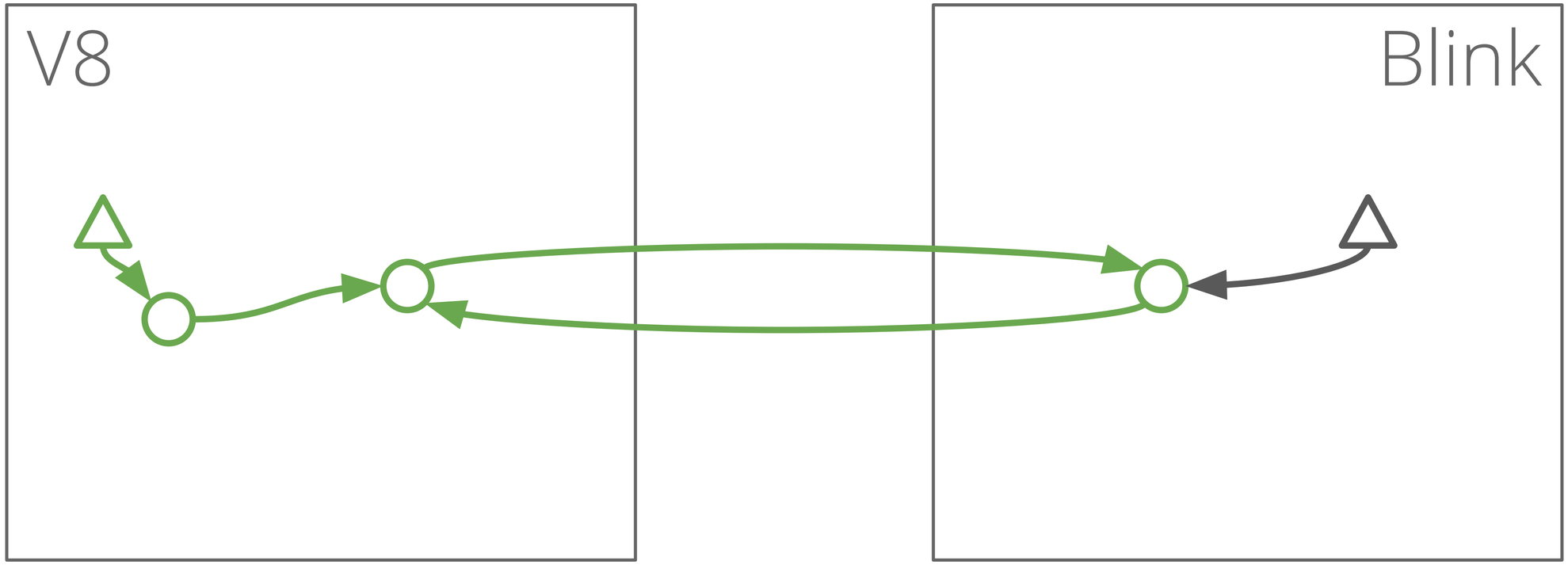

V8
Blink
Root reference
Weak reference
Traced reference



Root reference

Weak reference

Traced reference



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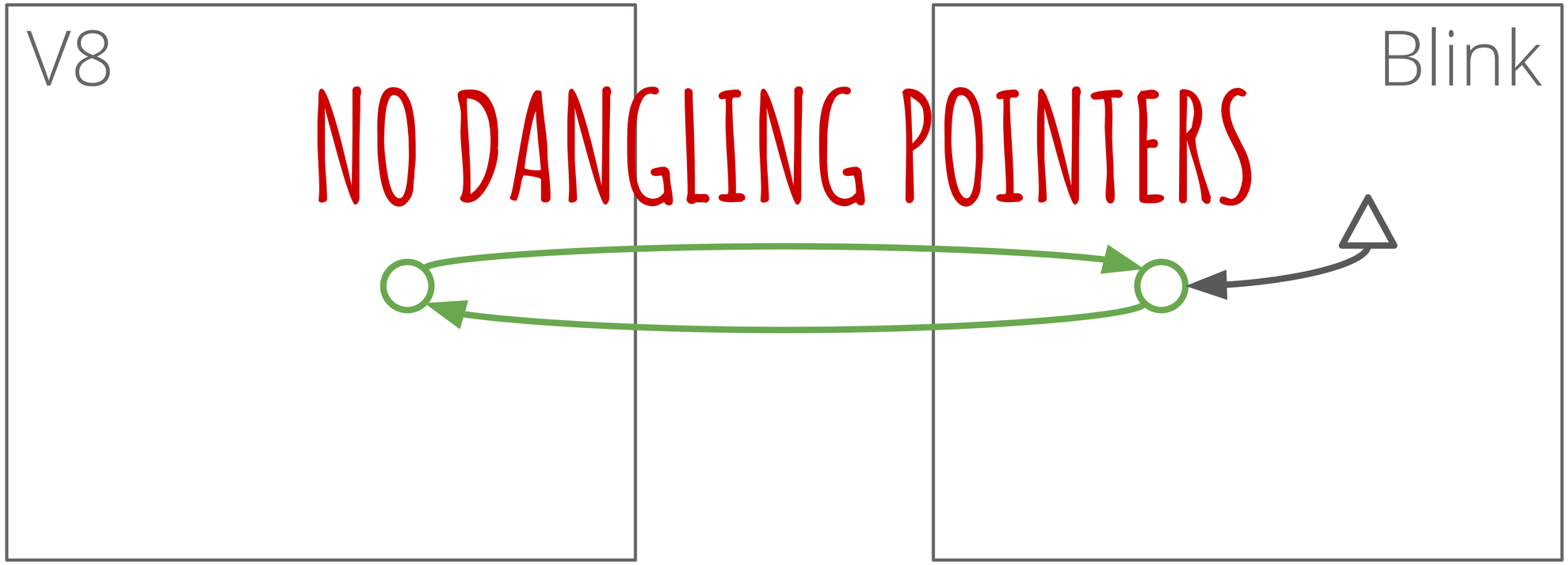

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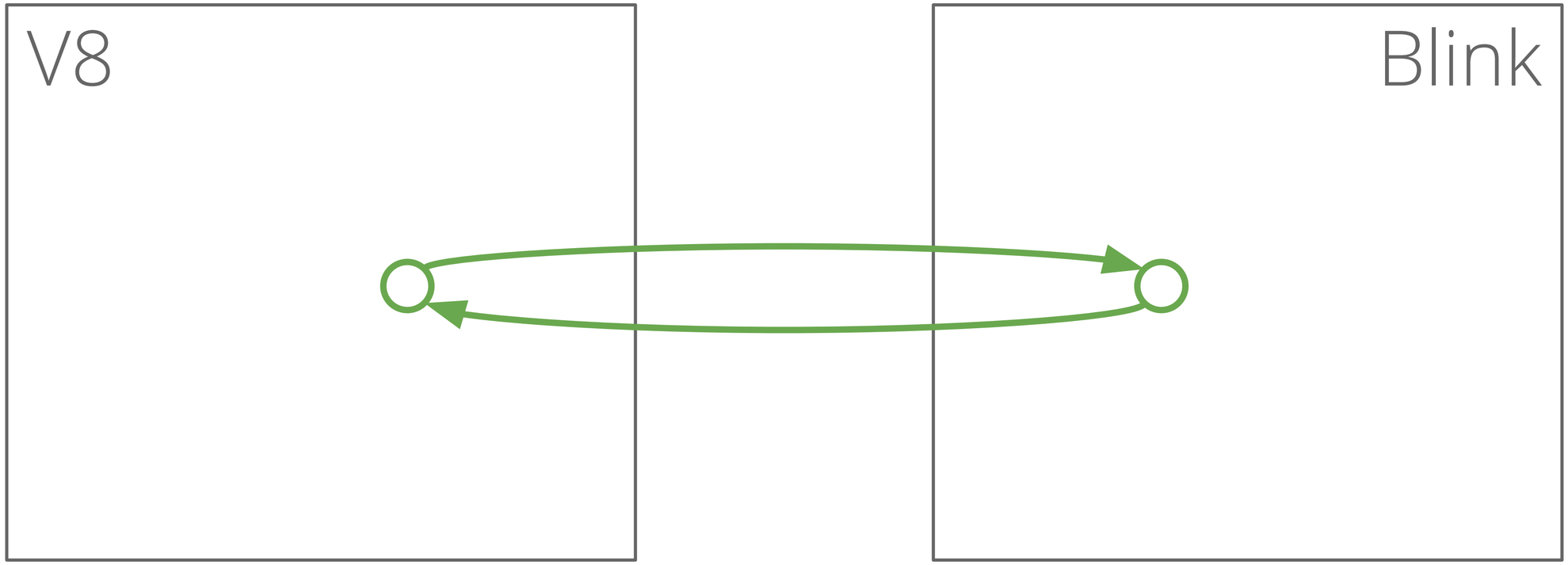

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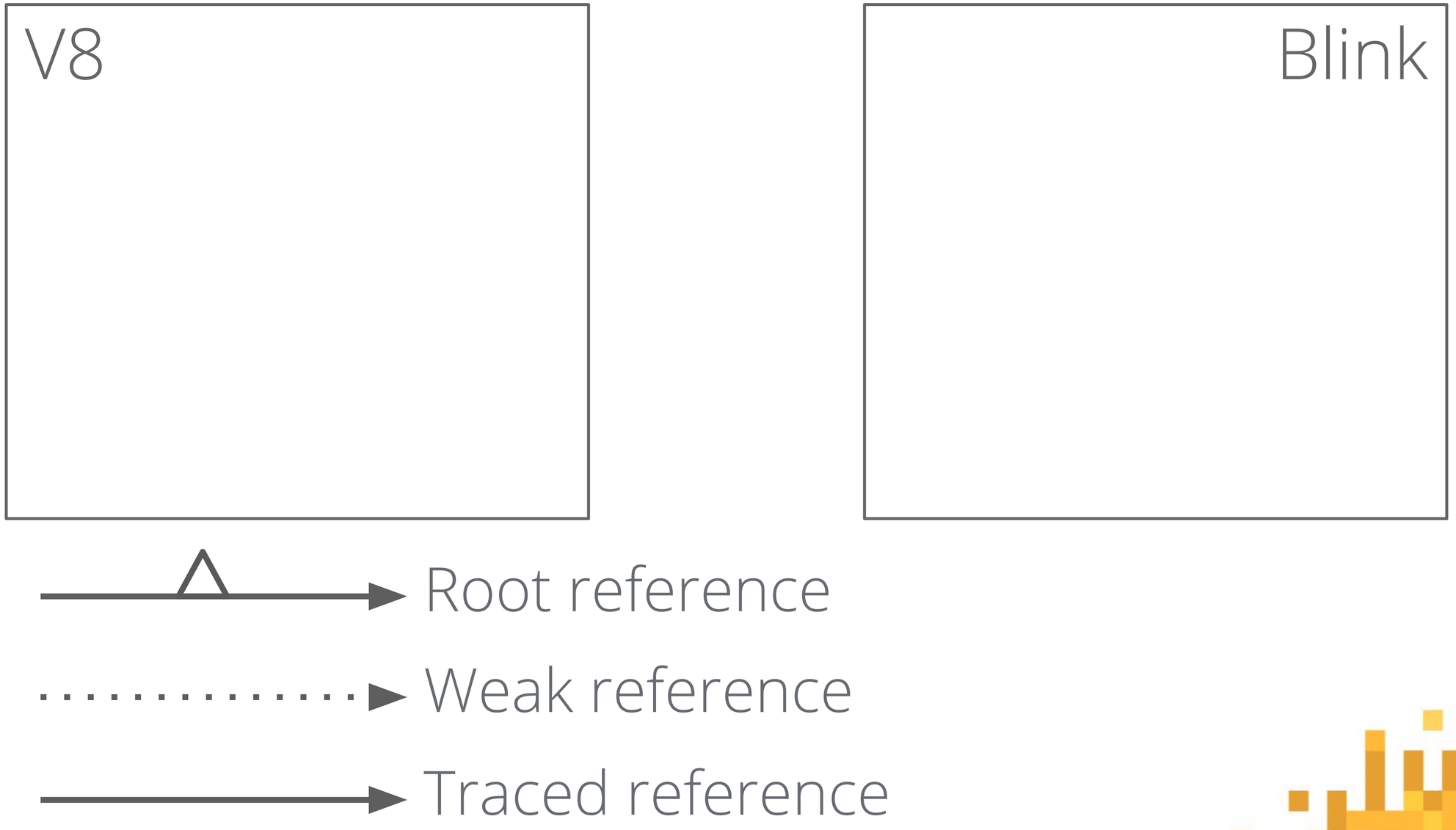
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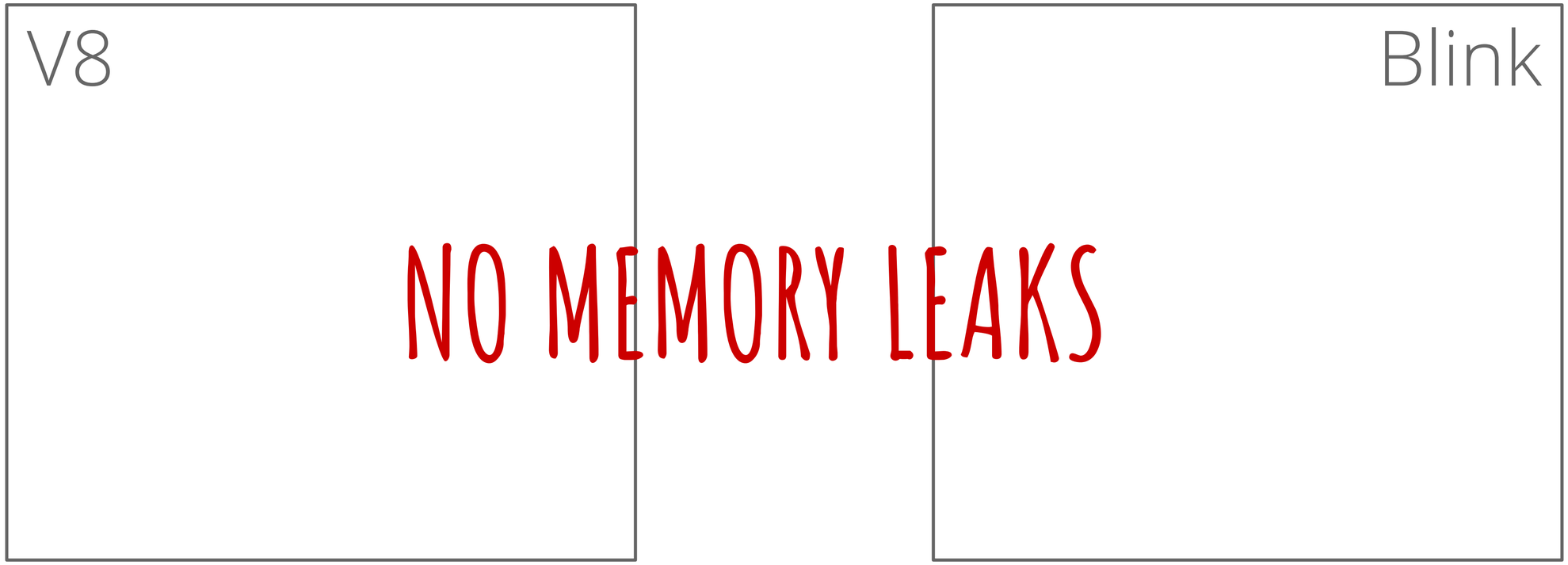


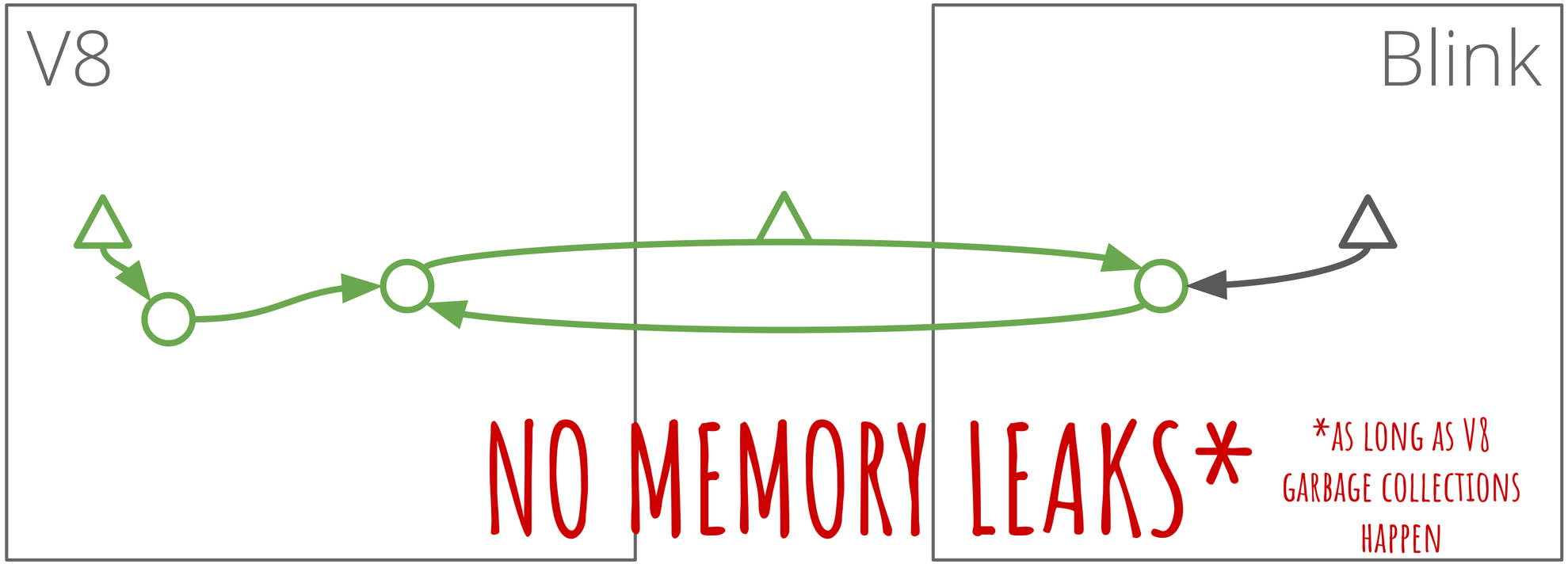
NO MEMORY LEAKS

Root reference

Weak reference

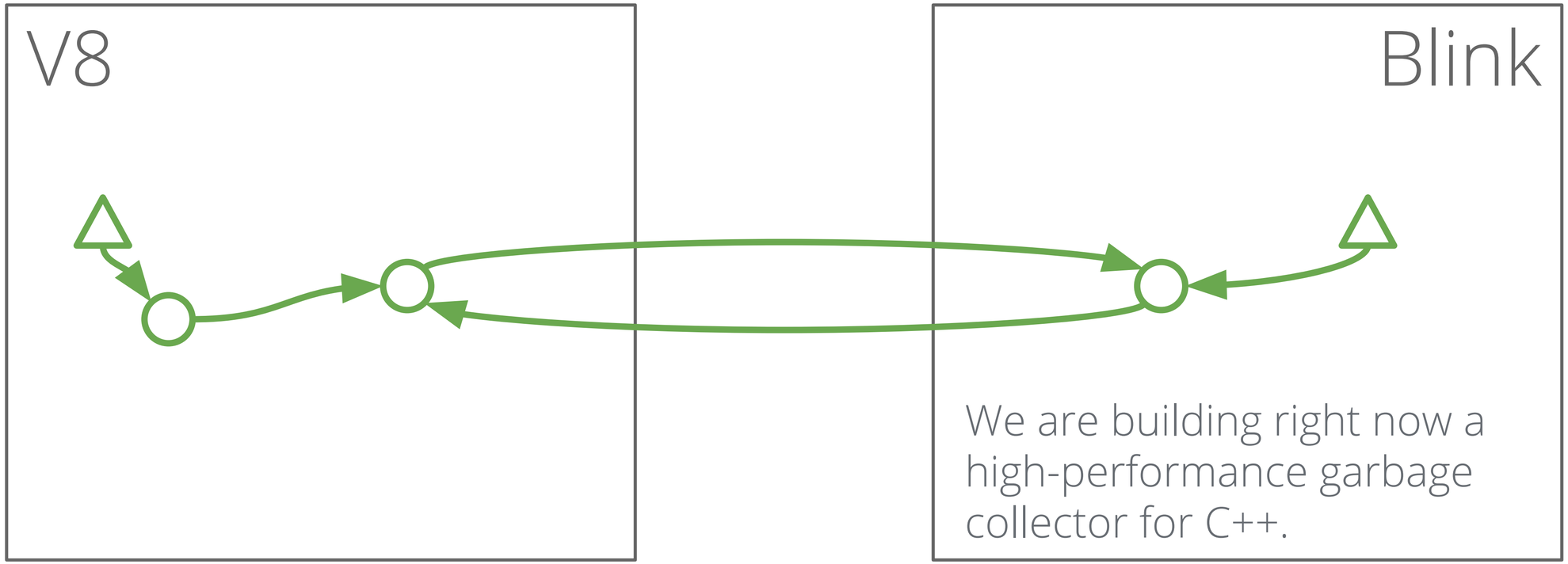
Traced reference

Incremental Wrapper Tracing: From V8 to Blink and Back



Cross-Component Garbage Collection [OOPSLA'18]
Garbage Collection as a Joint Venture [Communications ACM 62(6)]

Today: Unified V8 and Blink Garbage Collection



Thanks!

Hannes Payer
Google|Chrome|V8
https://research.google.com/pubs/HannesPayer.html