Go GC:
Latency Problem Solved

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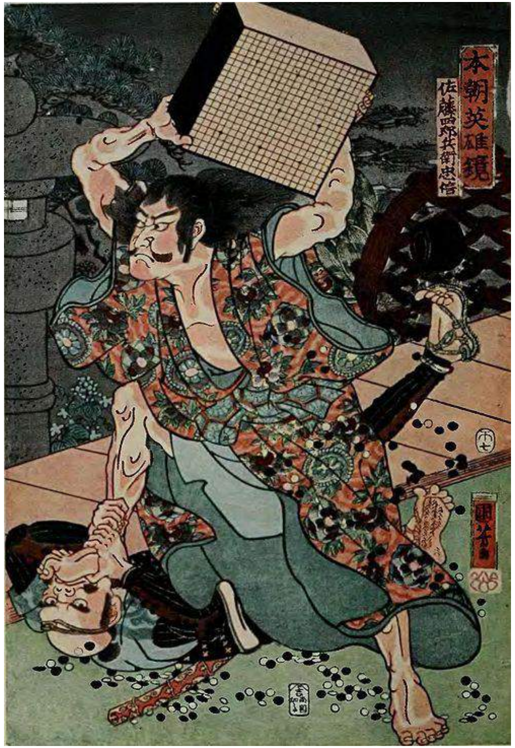
My Codefendants: The Cambridge Runtime Gang



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Making Go Go: Establish A Virtuous Cycle

News Flash:

2X Transistors != 2X Frequency

More transistors == more cores

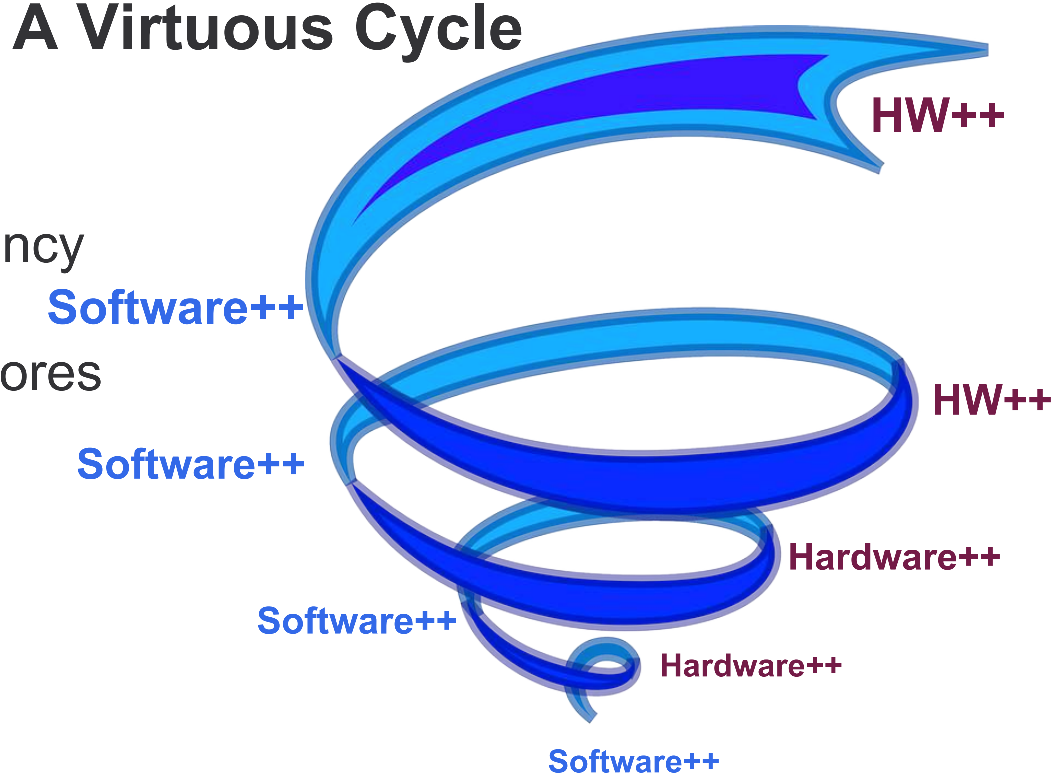
Only if software uses more cores

Long term

Establish a virtuous cycle

Short term

Increase Go Adoption

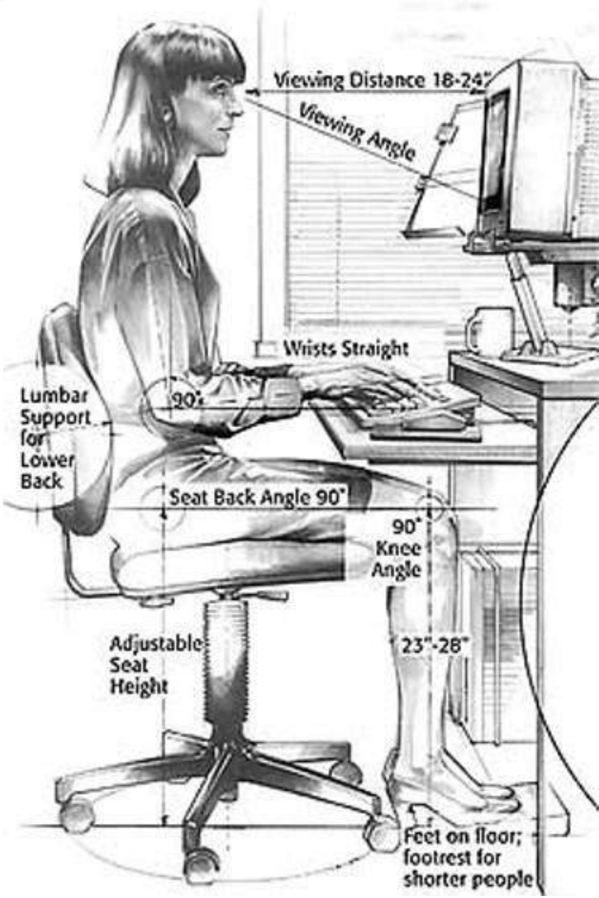


#1 Barrier: GC Latency

When is the best time to do a GC?

When nobody is looking.

Using camera to track eye movement
When subject looks away do a GC.



https://upload.wikimedia.org/wikipedia/commons/3/35/Computer_Workstation_Variables.jpg

Pop up a network wait icon

https://commons.wikimedia.org/wiki/File:WIFI_icon.svg#globalusage

Or
Trade Throughput for Reduced GC Latency

Latency

Nanosecond

1: Grace Hopper Nanosecond 11.8 inches

Microsecond

5.4: Time light travels 1 mile in vacuum

Millisecond

1: Read 1 MB sequentially from SSD

20: Read 1 MB from disk

50: Perceptual Causality (cursor response threshold)

50+: Various network delays

300: Eye blink

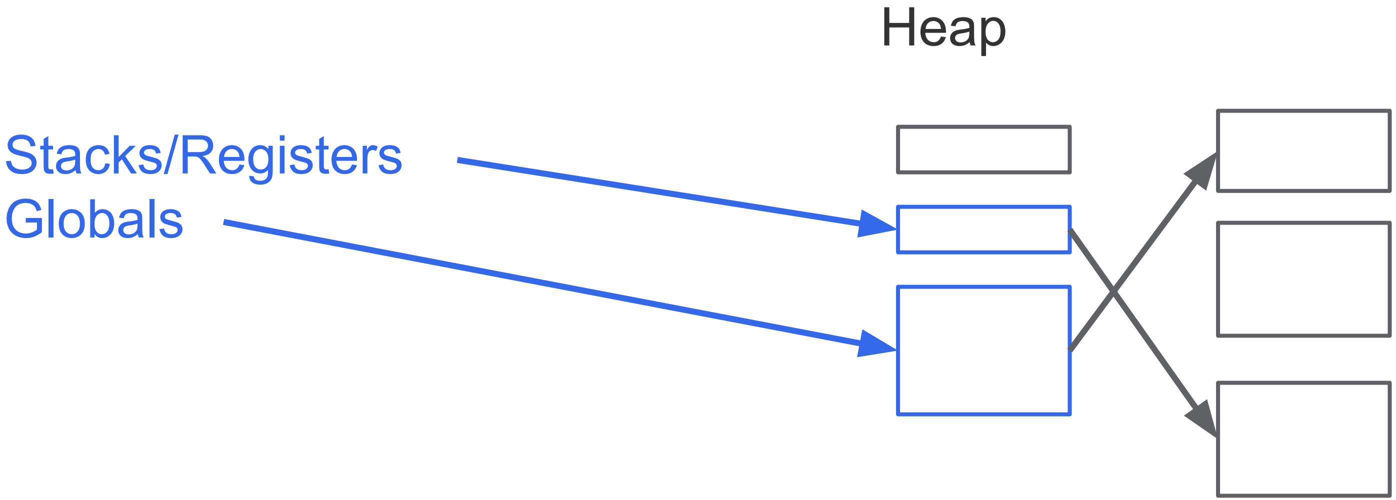
Go isn’t Java: GC Related Go Differences

Go	Java
Thousands of Goroutines	Tens of Java Threads
Synchronization via channels	Synchronization via objects/locks
Runtime written in Go	Runtime written in C
Leverages Go same as users	
Control of spatial locality	Objects linked with pointers
Objects can be embedded	
Interior pointers (&foo.field)	

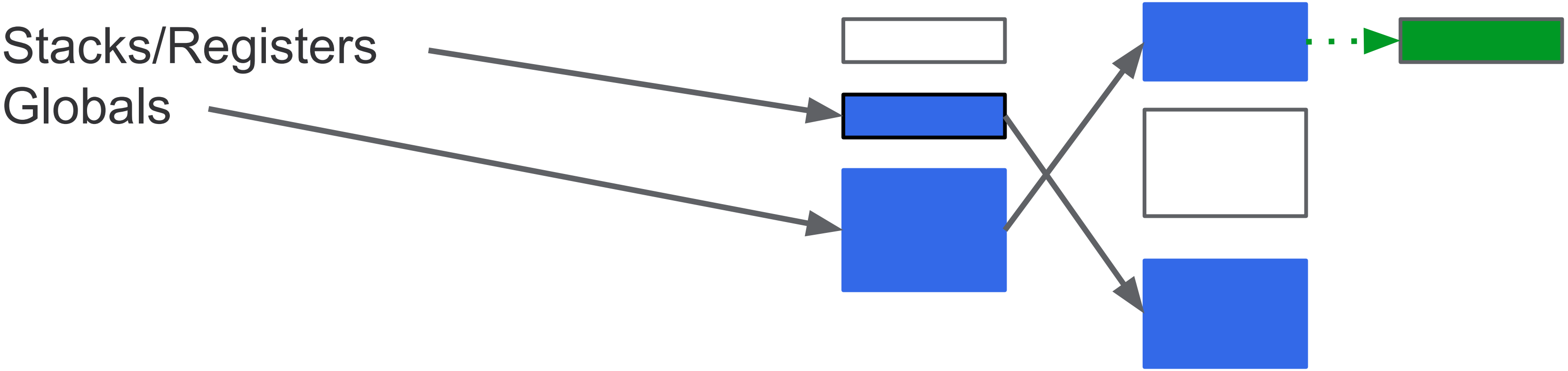
Let’s Build a GC for Go

GC 101

Scan Phase



Mark Phase

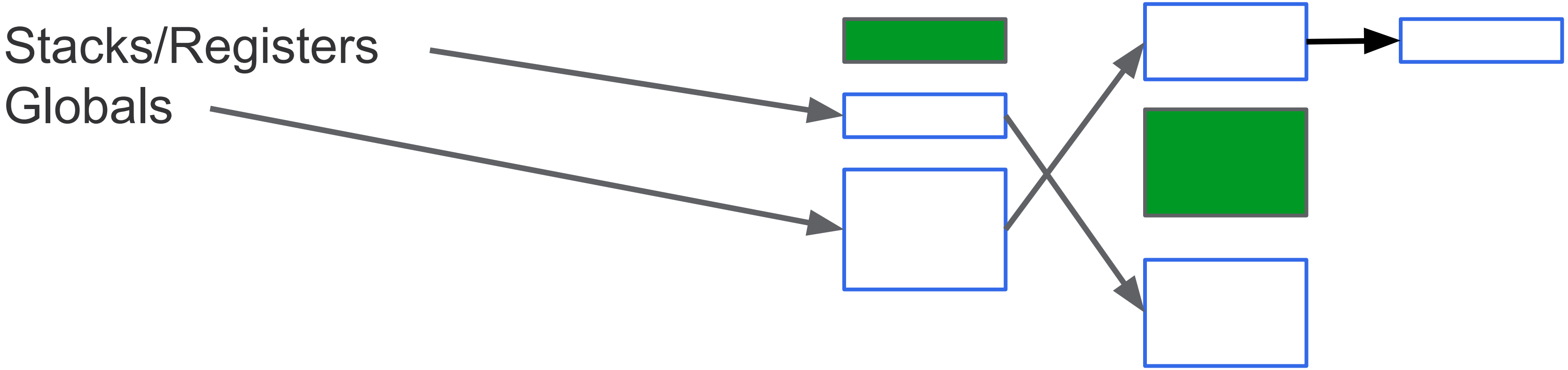


Stacks/Registers

Globals

Righteous Concurrent GC struggles with Evil Application changing pointers

Sweep Phase



Stacks/Registers

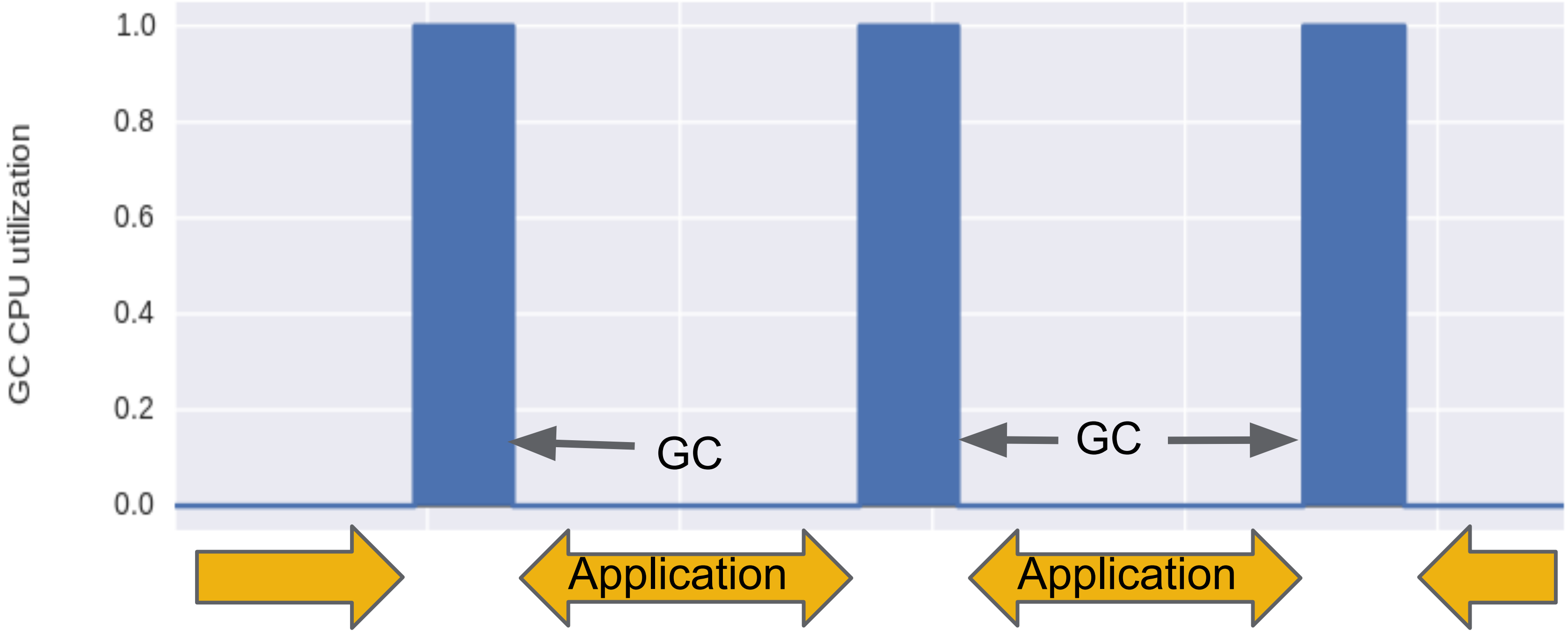
Globals

GC Algorithm Phases

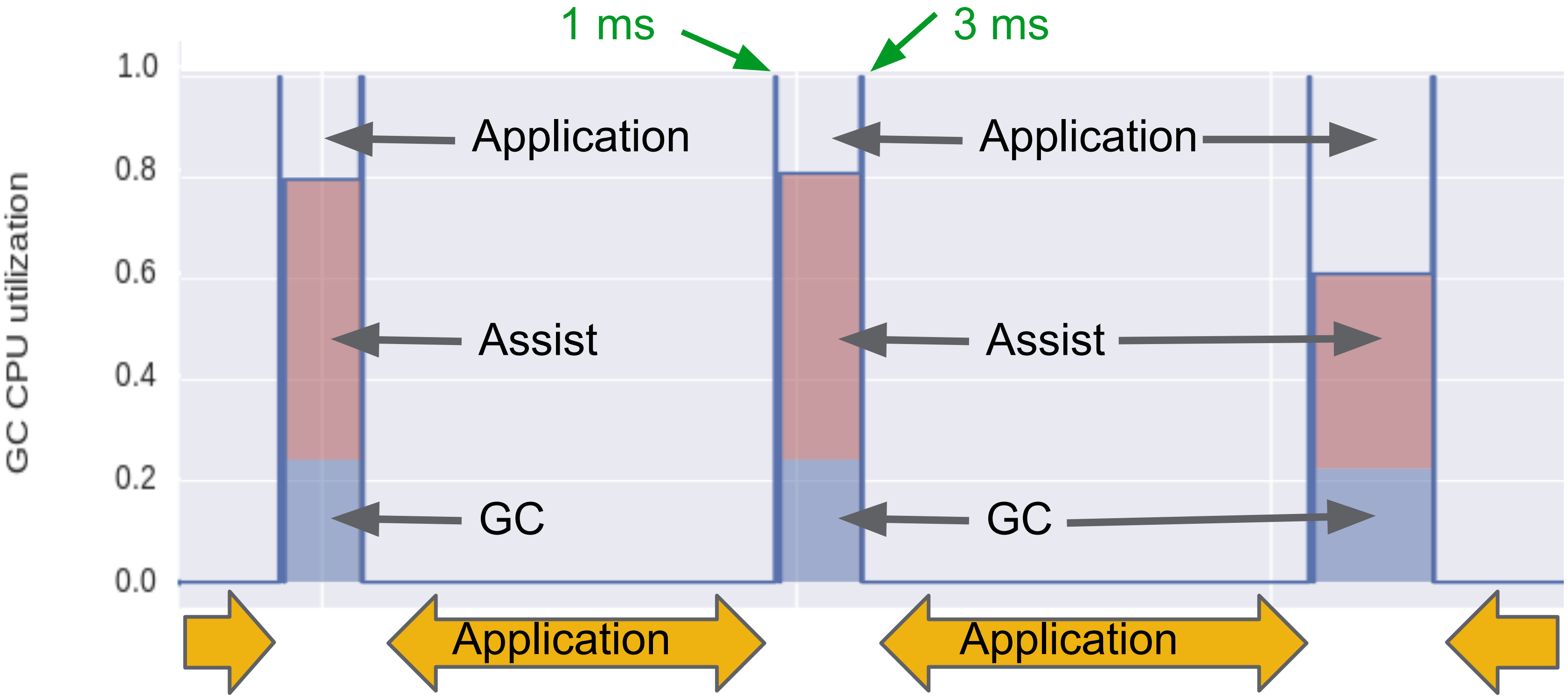
Off			GC disabled Pointer writes are just memory writes: *slot = ptr
Stack scan	WB on		Collect pointers from globals and goroutine stacks Stacks scanned at preemption points
Mark			Mark objects and follow pointers until pointer queue is empty Write barrier tracks pointer changes by mutator
Mark termination		STW	Rescan globals/changed stacks, finish marking, shrink stacks, … Literature contains non-STW algorithms: keeping it simple for now
Sweep			Reclaim unmarked objects as needed Adjust GC pacing for next cycle
Off			Rinse and repeat

Correctness proofs in literature (see me)

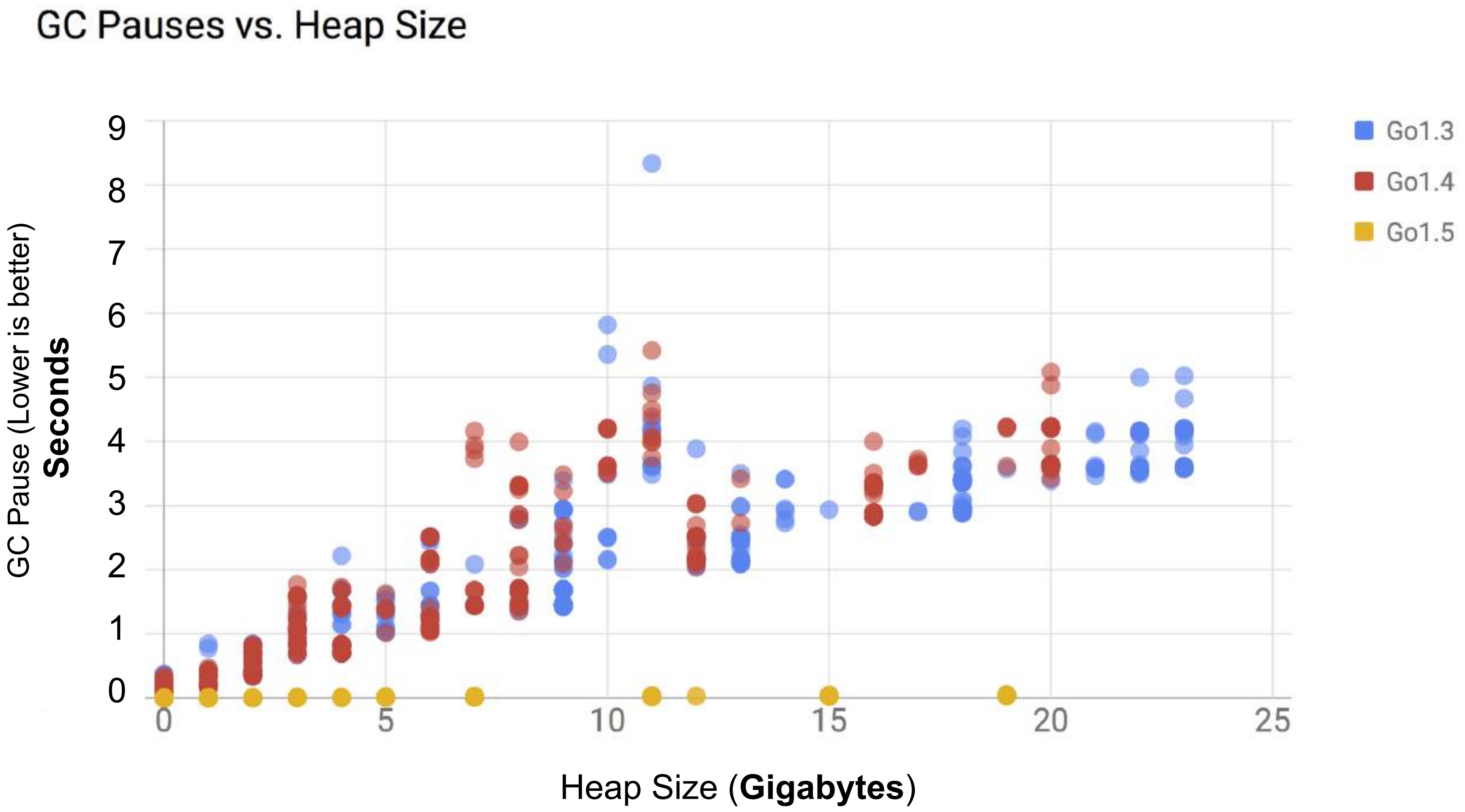
1.4 Stop the World



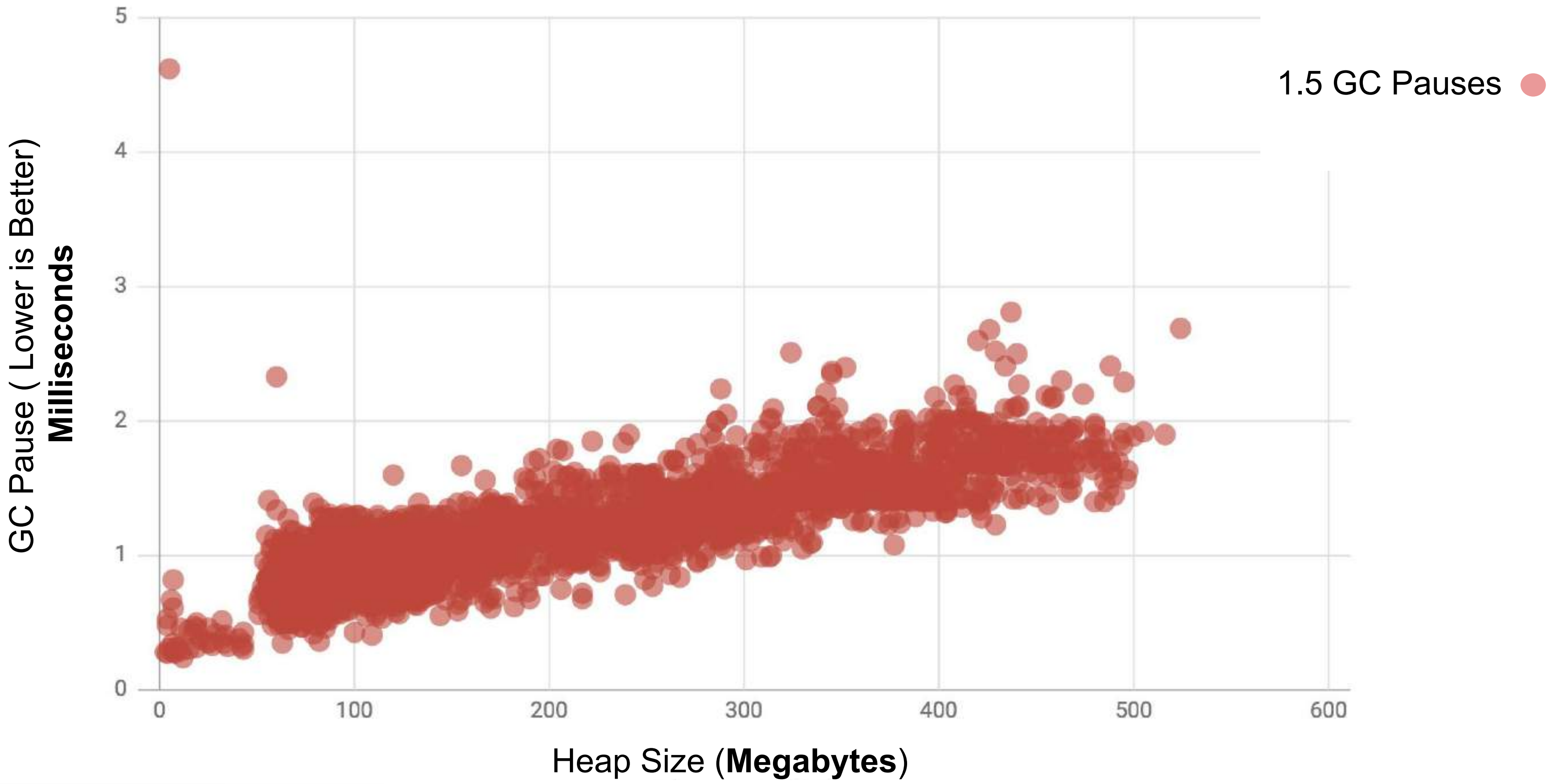
1.5 Concurrent GC



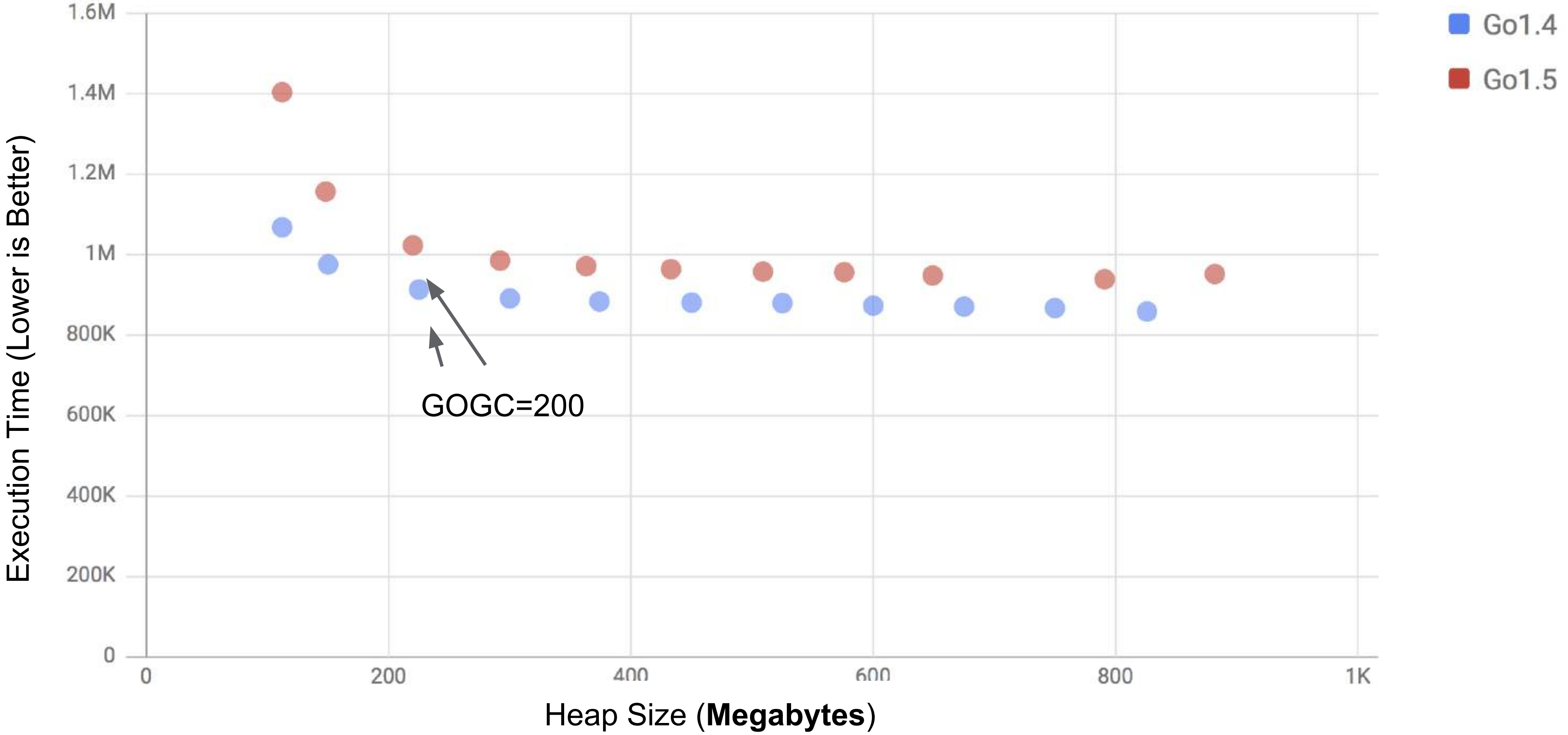
Garbage Benchmark



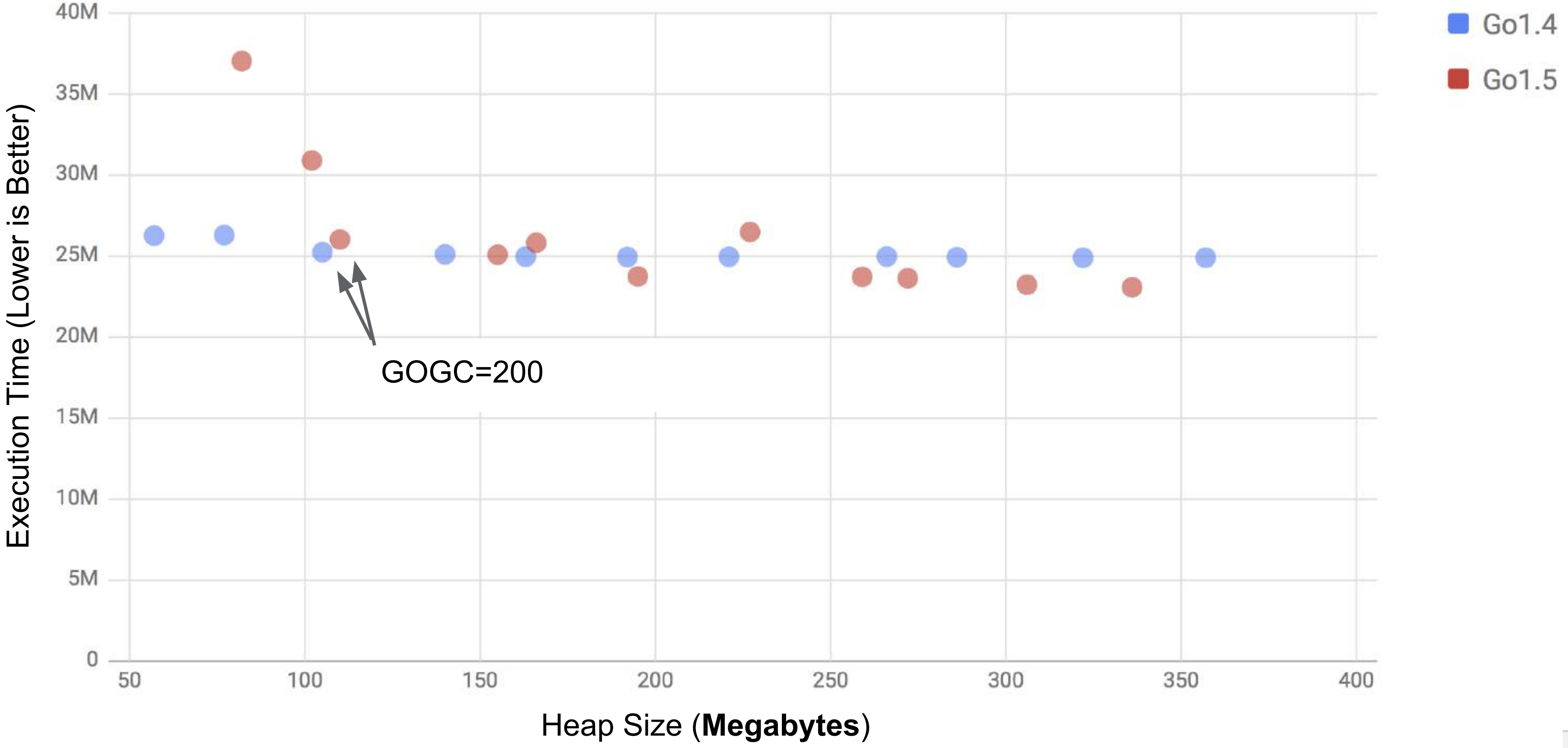
1.5 Garbage Benchmark Latency



Splay: Increasing Heap Size == Better Performance



JSON: Increasing Heap Size == Better Performance



Onward

Tell people that GC is not a barrier with Go’s low latency GC

Tune for even lower latency, higher throughput, more predictability
    Find the sweet spot.

1.6 work will be use case driven:
    Let’s talk.

Increase Go Adoption
Establish Virtuous Cycle

Questions