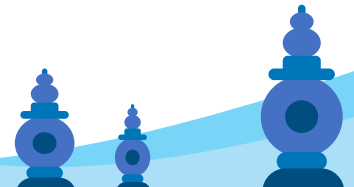
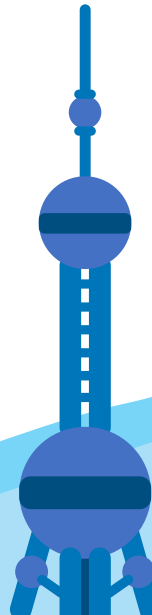
Alibaba Group 阿里巴巴集团

Java自动内存管理技术

现状和未来

陆 传胜 @阿里巴巴

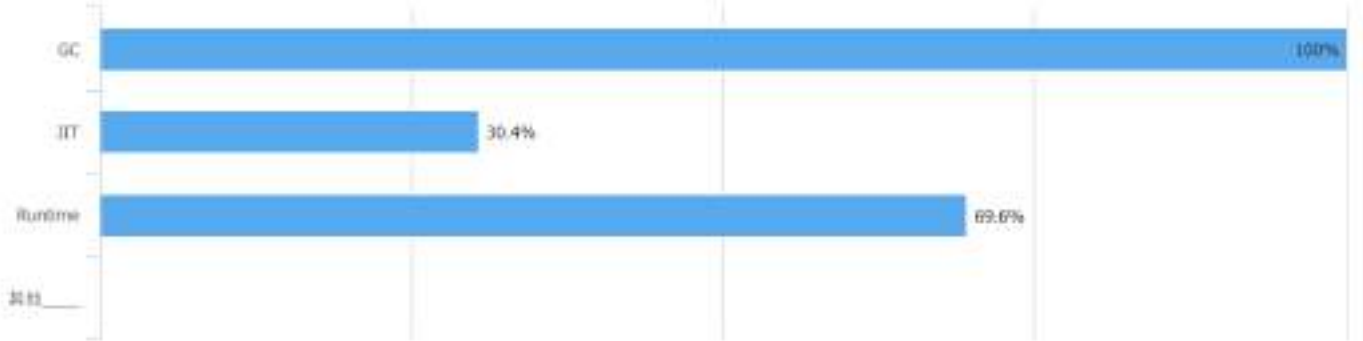




0x1,为什么要讨论内存管理

Alibaba Group 阿里巴巴集团

GreenTea JUG 2018-03



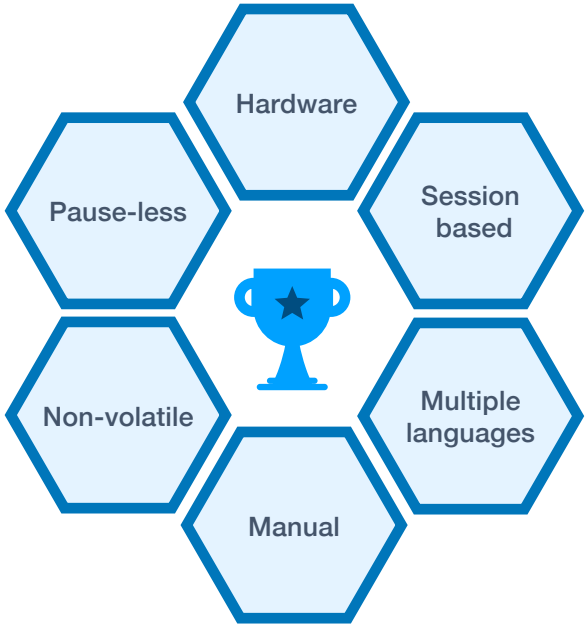
GreenTea JUG

http://greenteajug.cn/

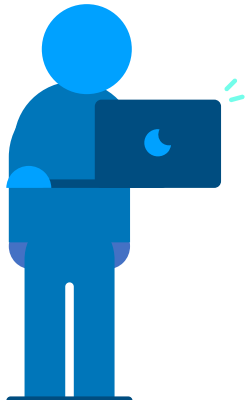
也许是因为新的投资方式

Alibaba Group
阿里巴巴集团

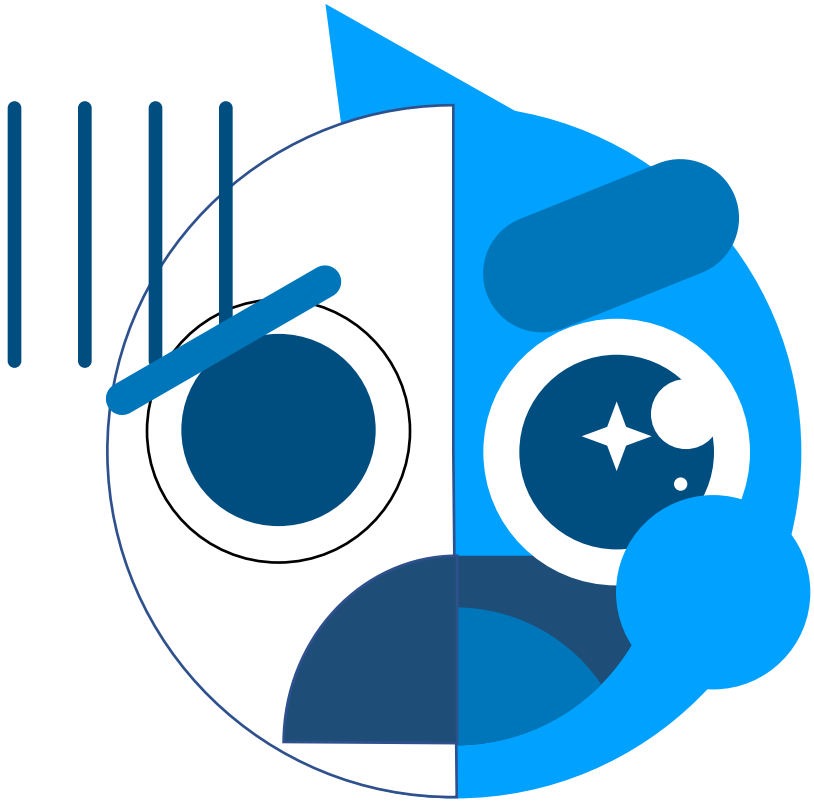
WHO


Hardware
Pause-less
Session based
Non-volatile
Multiple languages
Manual

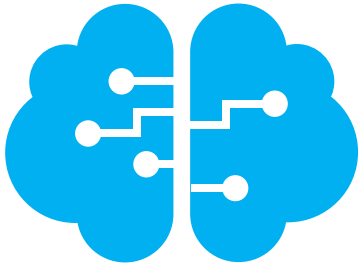

OPS
Stable
KPI
Perf
Cost



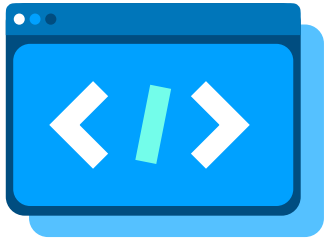
价值和手段



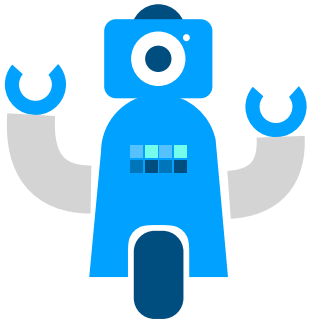
本次视角



互联网行业

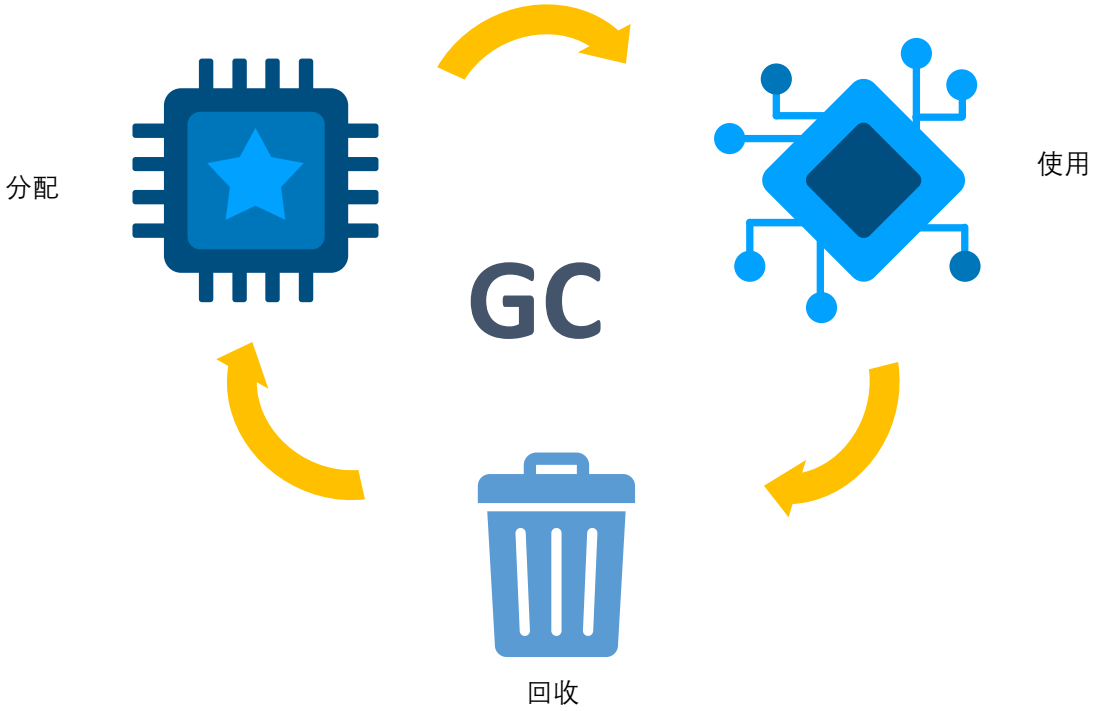


工程实践

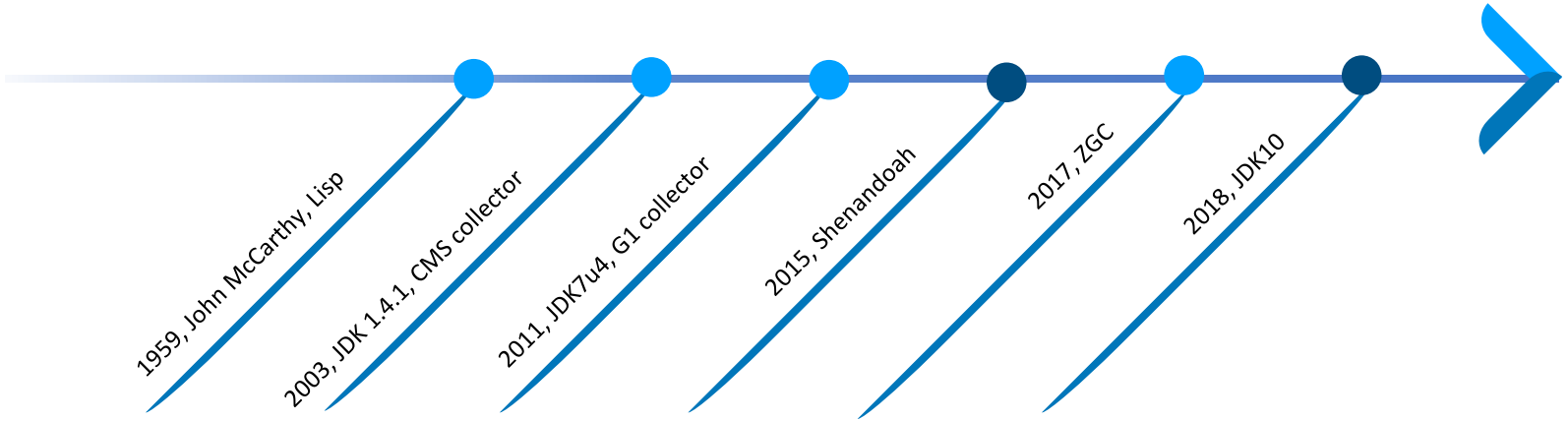


“旁观者”

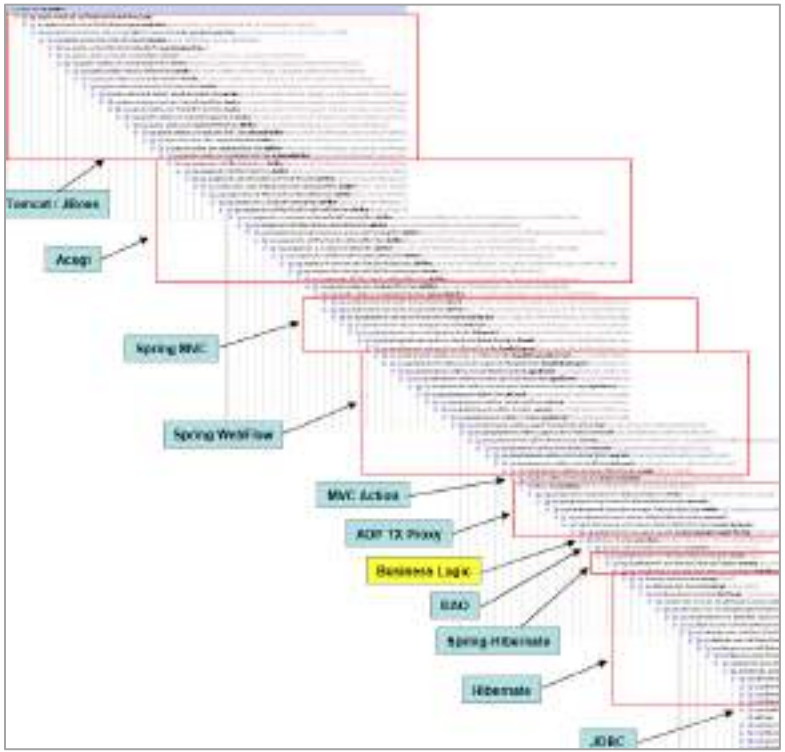
内存管理的元素

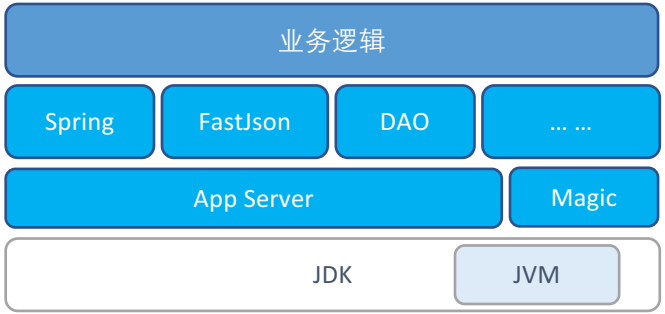


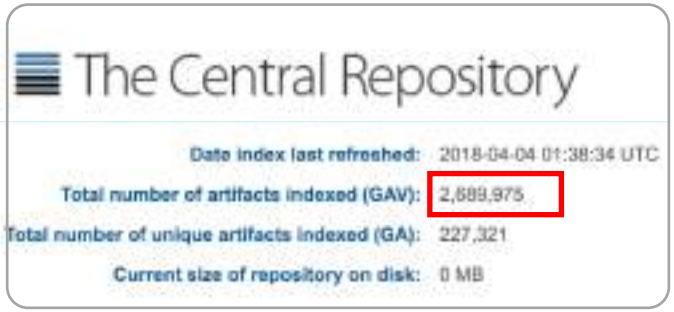
蓦然回首


1959, John McCarthy, Lisp
2003, JDK 1.4.1, CMS collector
2011, JDK7u4, G1 collector
2015, Shenandoah
2017, ZGC
2018, JDK10

现代Java系统的趋势



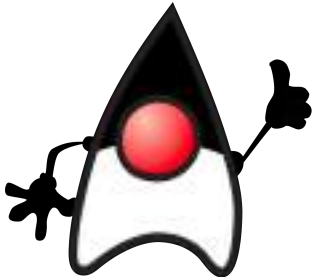




对内存管理的挑战

- 复杂的对象生命周期模式
- 难以预料的内存使用方式
- 多线程与内存
- 可预测性和易用性
- 性能

互联网公司的选择



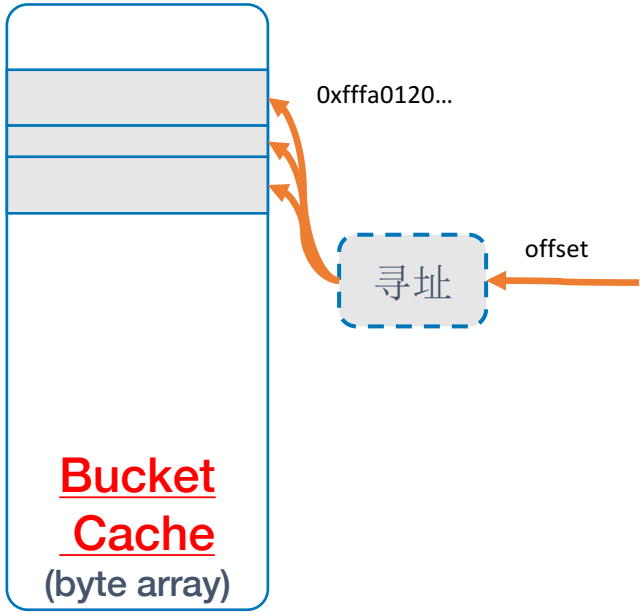
- JDK自带的回收器
- 可以胜任90%的工作

- 深度定制现有实现
- 阿里

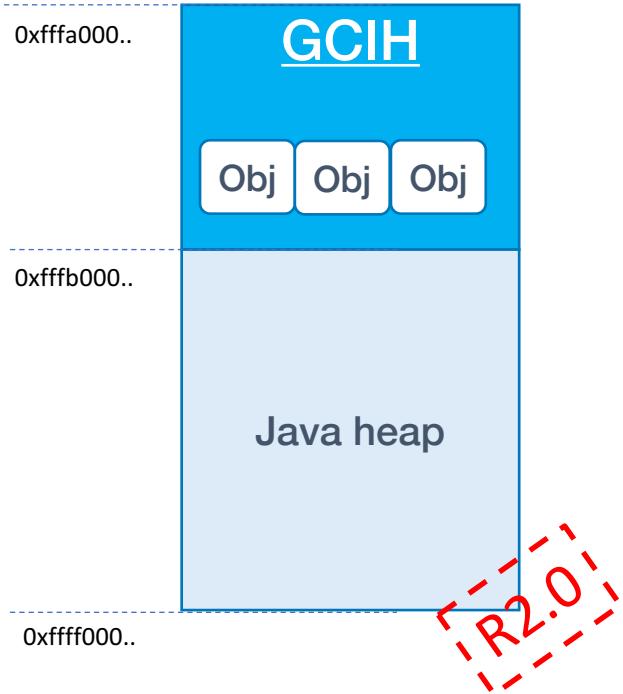
- 商业版垃圾回收器
- C4回收器

0x2,最好的内存管理是不用管理

一个尝试: Hbase Bucket Cache

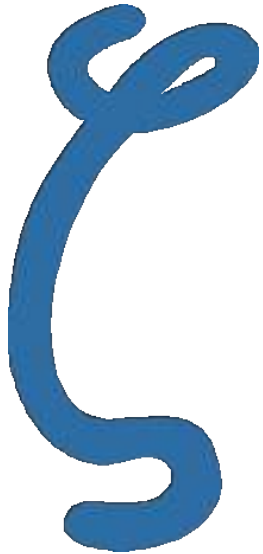


另一个尝试: GCIH (GC Invisible Heap)



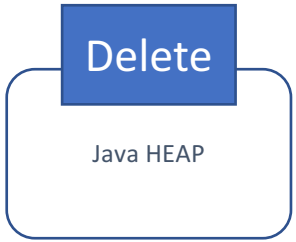
破罐子破摔……

- 干脆什么都不要做了
- 场景
  - 短小的批处理任务
  - 测试任务…
- Epsilon GC
  - http://openjdk.java.net/jeps/318



如果您能接受的话....

- 我们给Java来添加
  - delete 操作！
- 半自动管理内存
  - GC + Delete
  - New + Delete



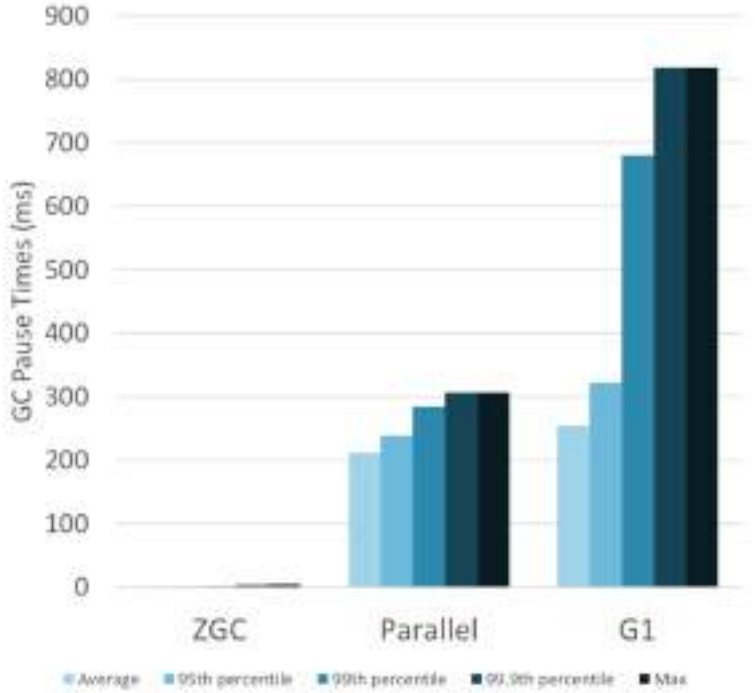
BridgedCHeap

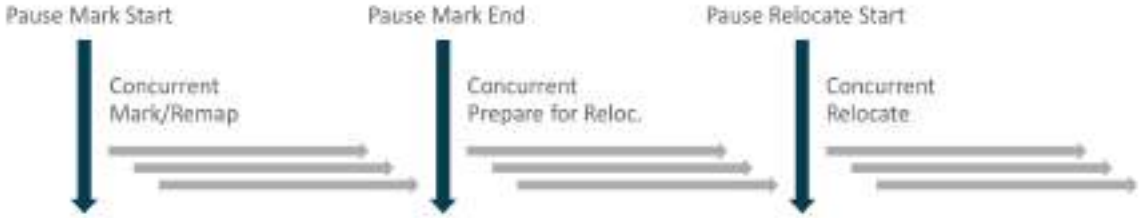
https://github.com/luchsh/bridgedCHeap

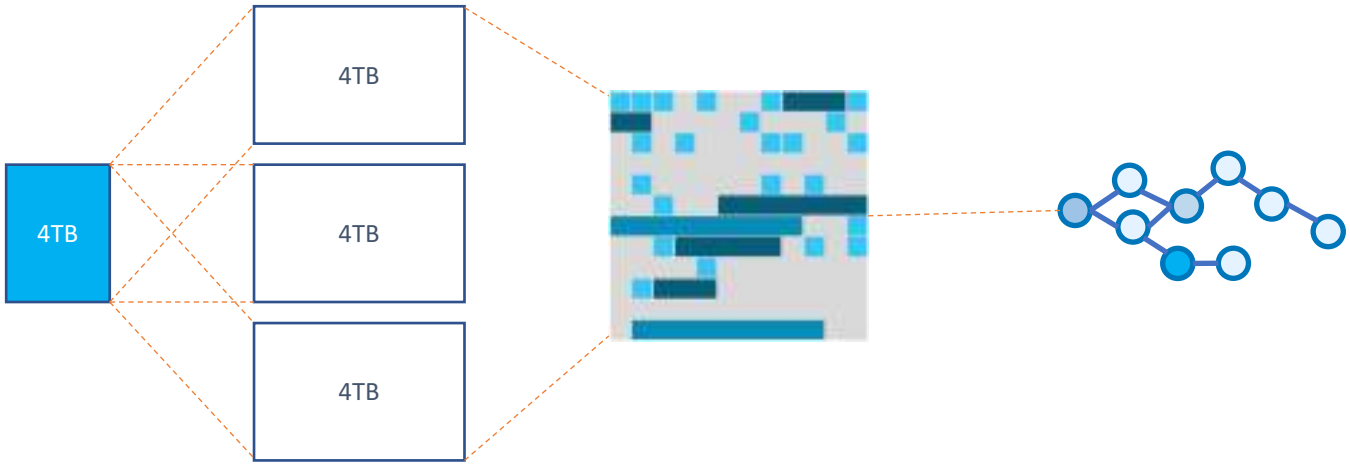
0x3, 降低内存管理的开销

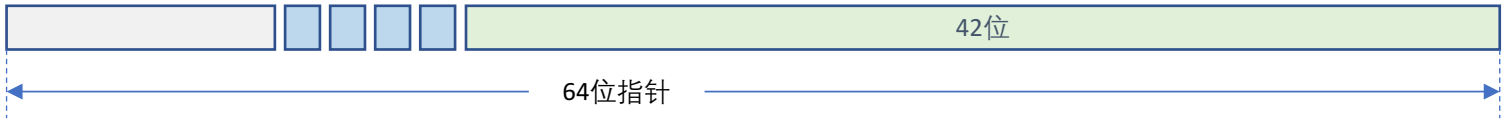
RI的动向

- ZGC
  - 固定时间暂停
  - 停顿时间大大缓解
  - 但是throughput有下降
- 可能是未来RI GC工作的基础
- Load barrier
- 15% throughput损失



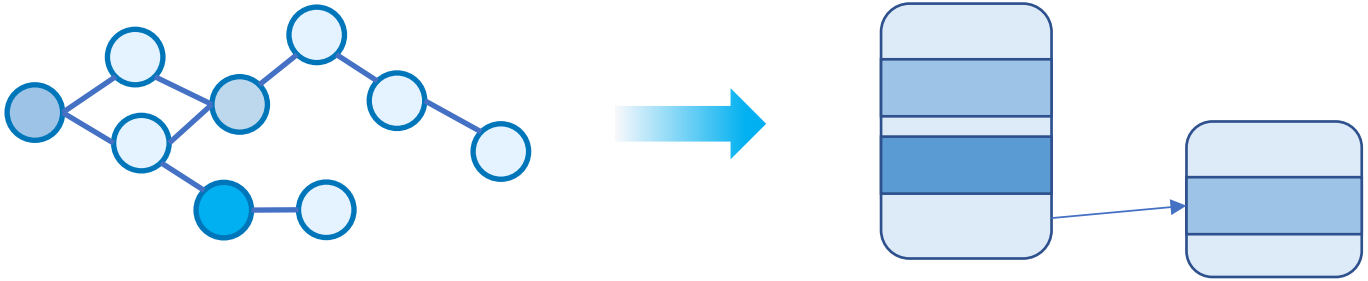

Pause Mark Start
Concurrent
Mark/Remap
Pause Mark End
Concurrent
Prepare for Reloc.
Pause Relocate Start
Concurrent
Relocate


4TB
4TB
4TB
4TB


42位
64位指针

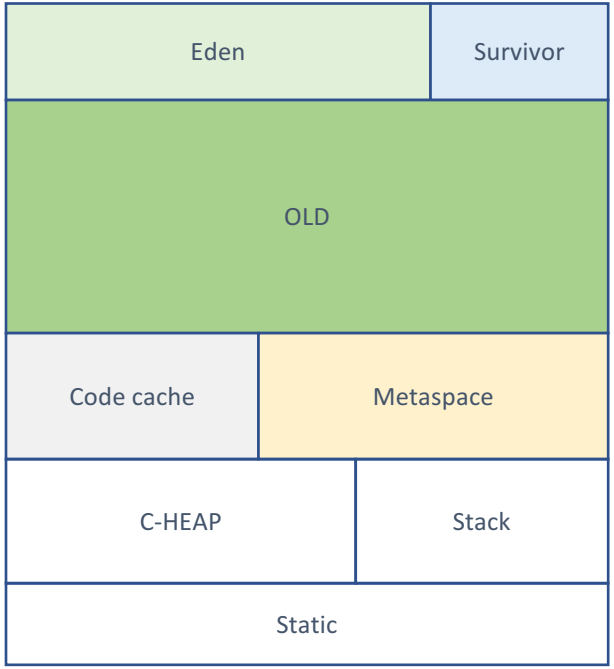
对象和类型之上

- Java 语言的局限性限制了GC的优化
- 虽然有Project Valhalla



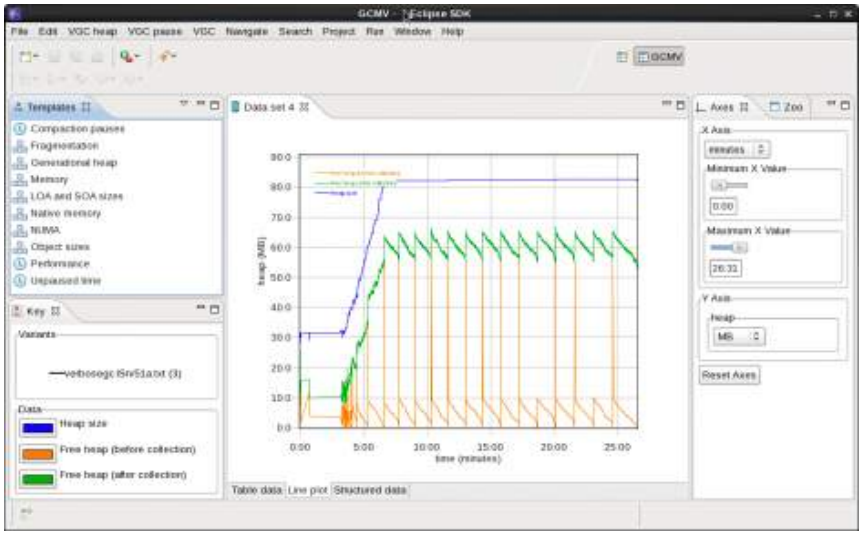
对于应用行为的观察

- 观察内存
  - 不只有heap
  - 分布
    - 声明周期
    - 大小
  - 分配
    - 速率
    - 比例



工欲善其事，必先profiling

- 宏观
  - GC Log，大部分的APM工具都是基于此
- 微观
  - Allocation site
  - 全生命周期计数
  - 死亡节奏
  - 对象移动
  - 对象图变更

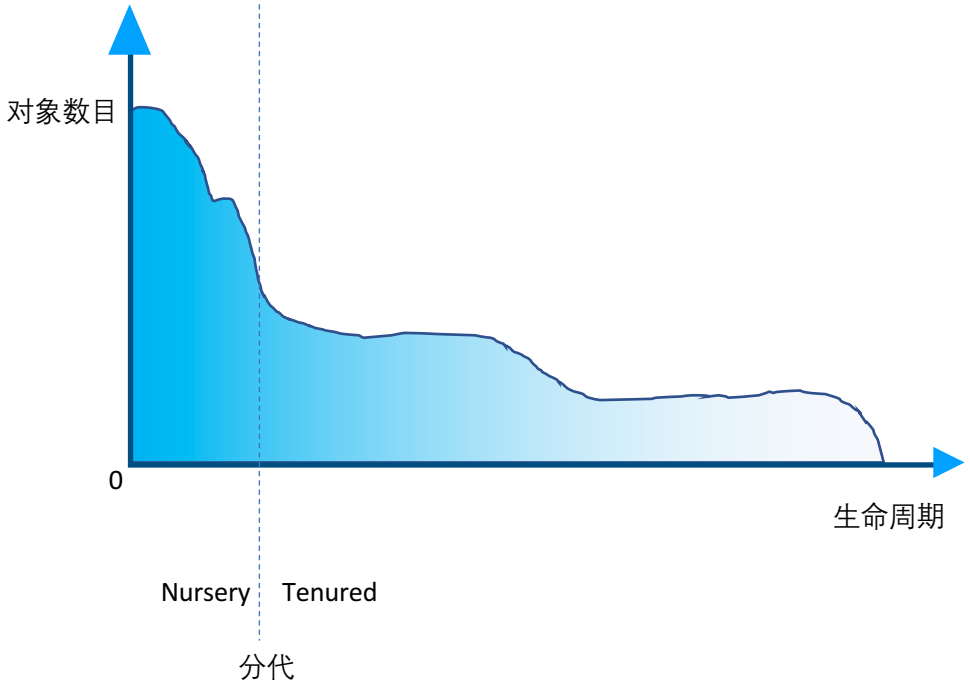


更细粒度的分配行为

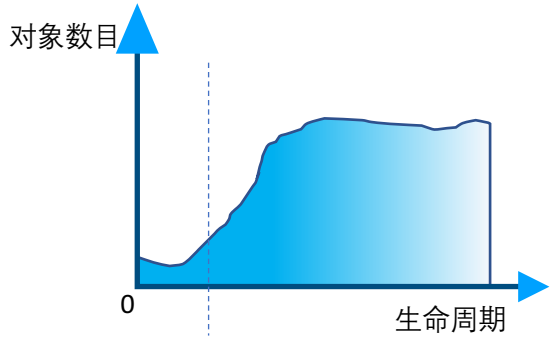
- 复杂的分配方式导致难以profile
- TLAB分配的，特别是JIT生成的代码

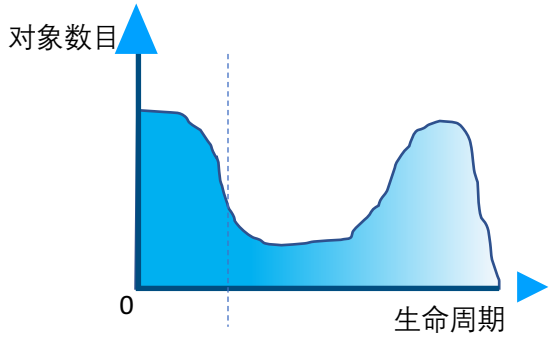
- 需要采集的信息导致海量数据
  - Stack
  - Age
  - Object move

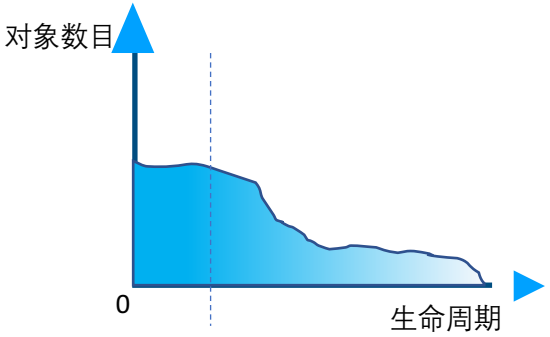
对象生命周期与分代假说

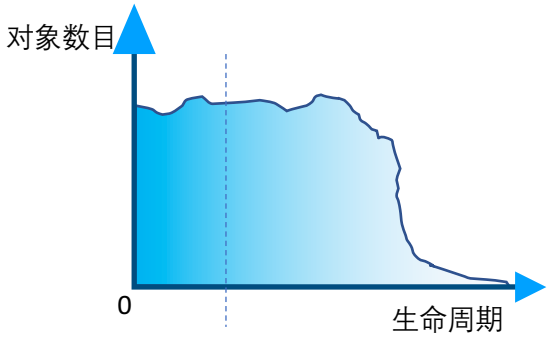


分代假说的例外



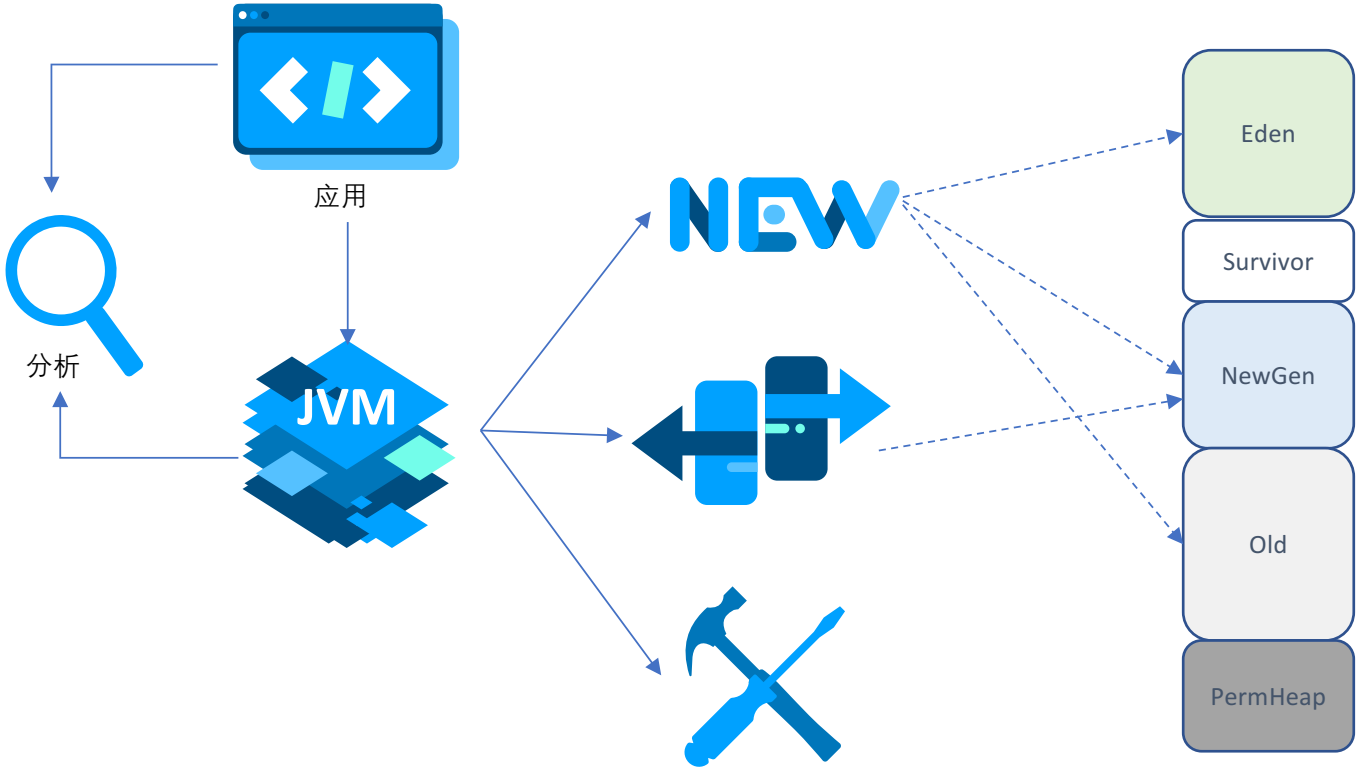




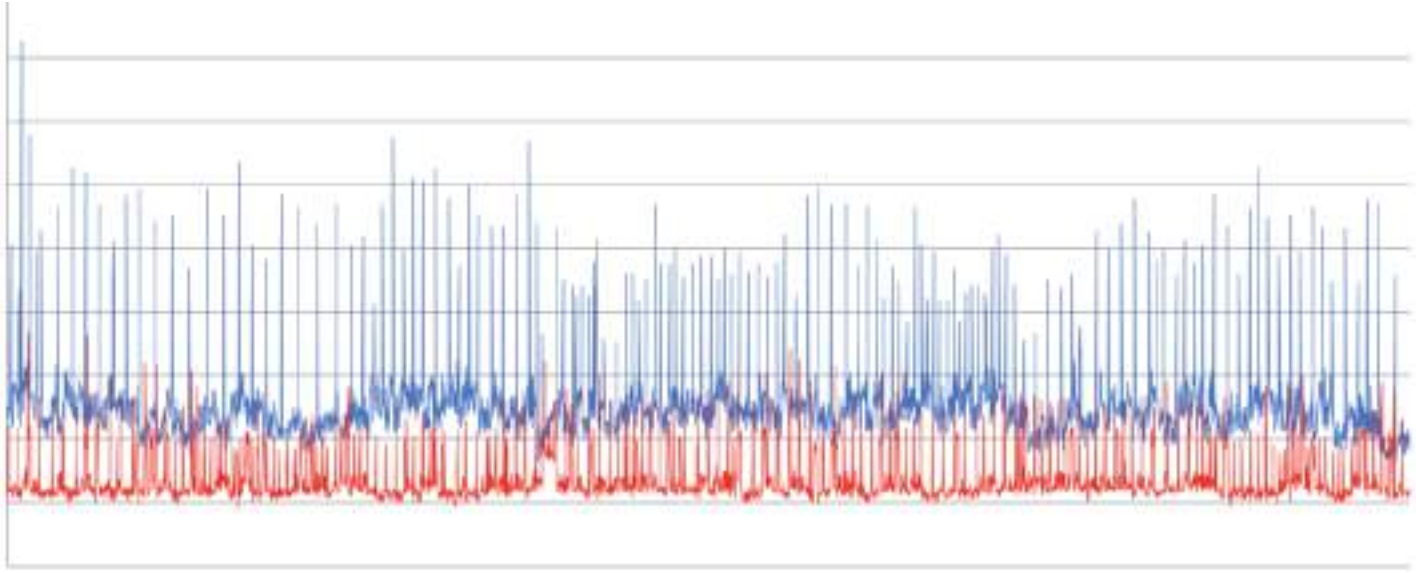


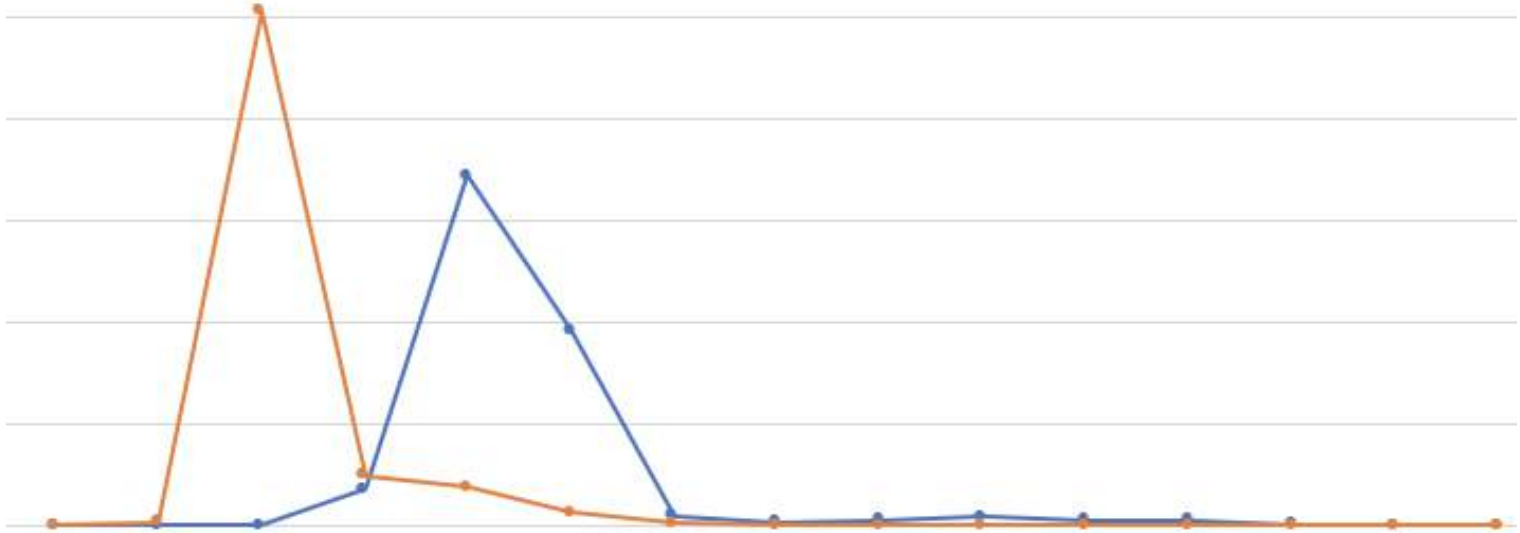
我们的一些探索：

- 一个现象
  - 无序的内存分布影响Gc效率
- VM和应用的结合
- 一个解法
  - 局部有序的对象分布
  - 不同的对象分布区域区域
  - 按照区域的方式进行回收
- 没有throughput损失!


应用
分析
JVM
NEW
Eden
Survivor
NewGen
Old
PermHeap

性能测试

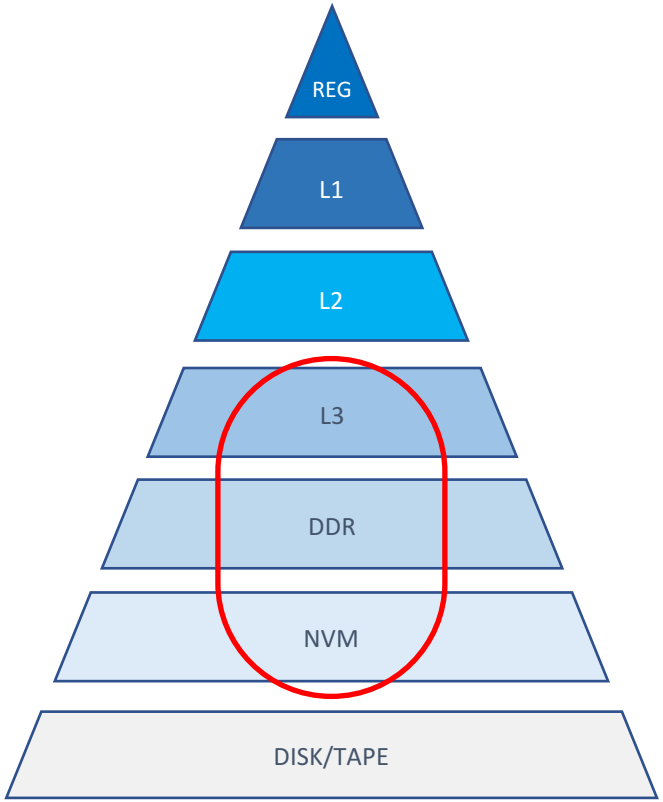




0x4, 榨取更多的好处

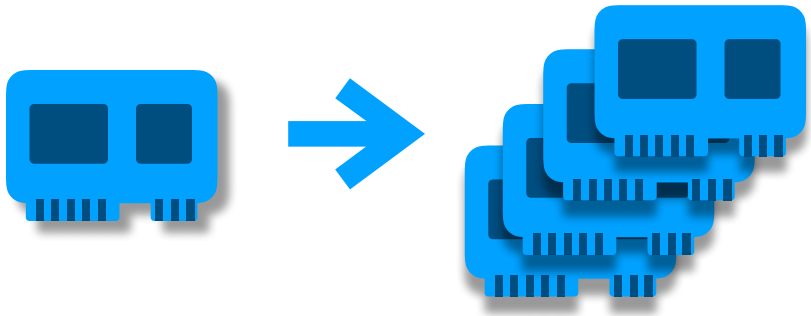
新硬件

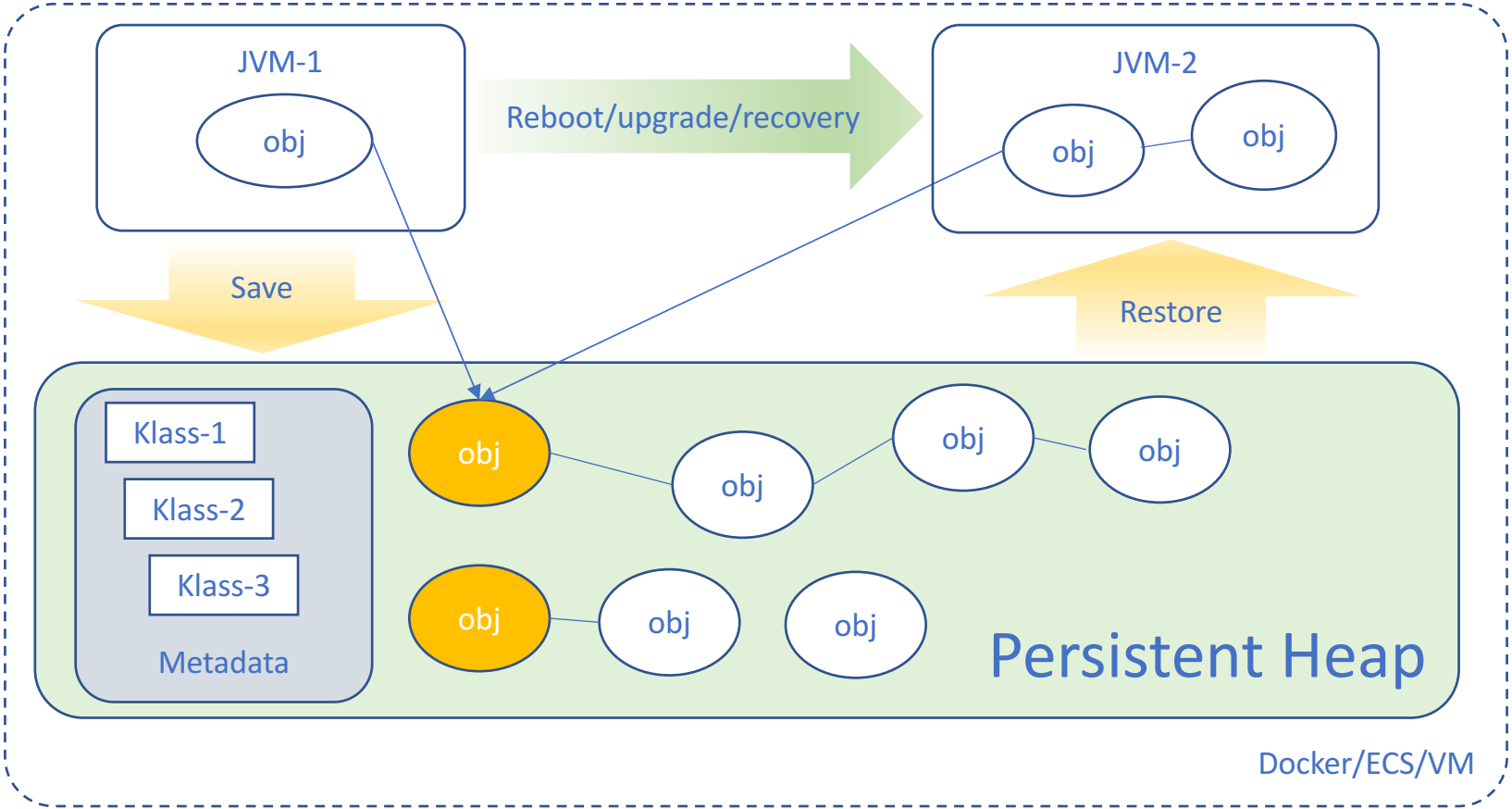
- 潜在的颠覆性
  - 更大
  - 更快
  - 更可控
  - 成本优势



Non-Volatile Memory

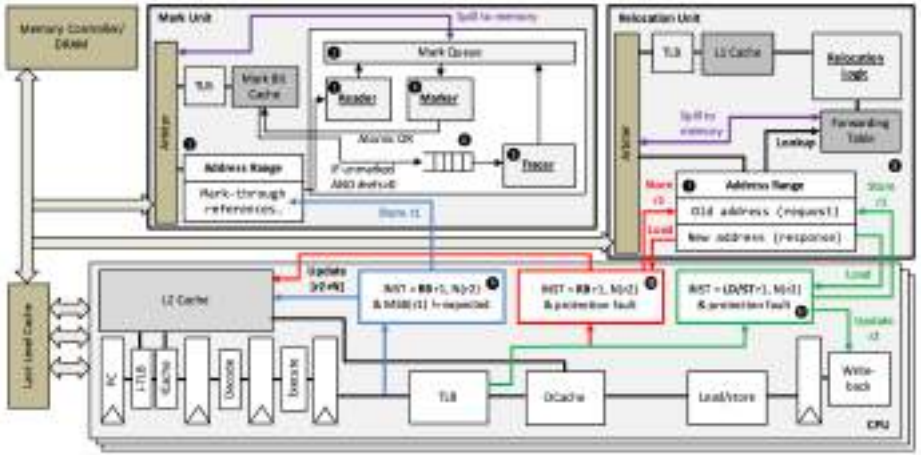
- 数据断电后不会丢掉
- 较快的访问速度
- 巨大的容量
- 低廉的价格




JVM-1
obj
Reboot/upgrade/recovery
JVM-2
obj
obj
Save
Restore
Klass-1
Klass-2
Klass-3
Metadata
obj
obj
obj
obj
obj
obj
obj
Persistent Heap
Docker/ECS/VM

置于硬件的垃圾回收

- 快
  - 直接可控MMU
  - 廉价的barrier
  - 硬件 “线程”

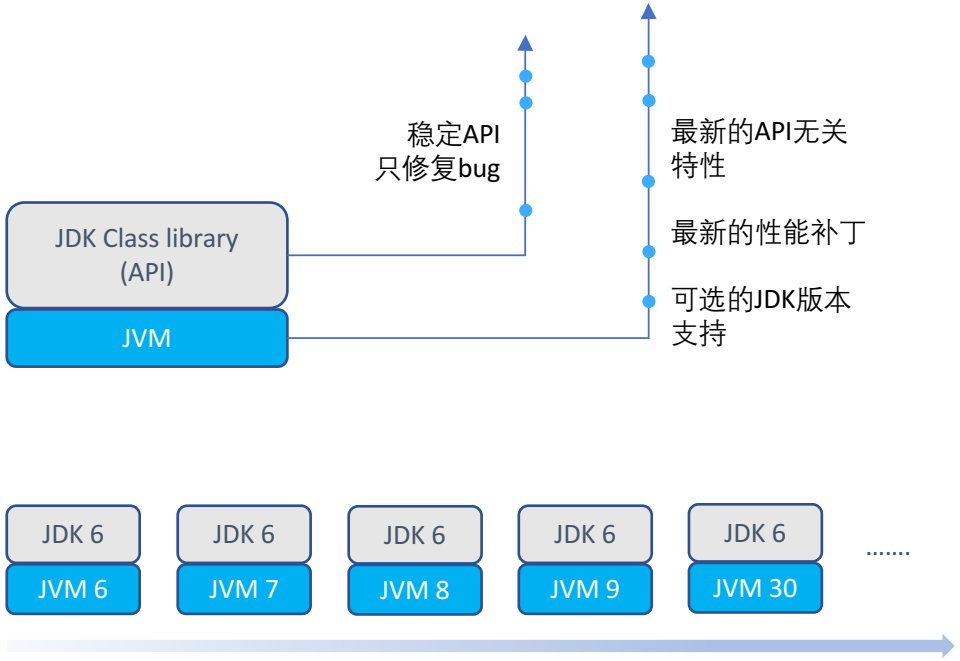


总结

- 短期的现实
  - 还得暂停
  - 并没有通用的银弹
- 可以期待
  - 标准GC接口的确定
  - 大堆无暂停的稳定GC
  - 更多开放的实现
  - Java作为通用平台

BACKUP

JVM-JDK独立发展


稳定API
只修复bug
最新的API无关
特性
最新的性能补丁
可选的JDK版本
支持
JDK Class library
(API)
JVM
JDK 6
JVM 6
JDK 6
JVM 7
JDK 6
JVM 8
JDK 6
JVM 9
JDK 6
JVM 30
.....

云计算

- 围观层面
  - Jvm是一个进程
  - 配合调度
- 宏观层面
  - 统一的平台
  - 互相之间的配合和通信