

[illegible]

第一次Minor GC

```
1 2021-03-31T14:08:50.731-0800: 0.205: [GC (Allocation Failure) [PSYoungGen: 131178K->21499K(153088K)] 131178K->48782K(502784K), 0.0203588 secs] [Times: user=0.02 sys=0.05, real=0.02 secs]
```

第一次GC发生时间在程序启动后的0.205秒，是一次Minor GC，并且发生原因是Allocation Failure，表明本次引起GC的原因是因为在年轻代中没有足够的空间能够存储新的数据了。

本次Minor GC共回收掉了年轻代 131178K - 21499K = 109679K（约107M）的容量。

同时堆内存从131178K - 48782K = 82396K（约80M）。109679K - 82396K = 27283k（约27M），耗时为0.0203588 secs

本次总共有27M的数据从年轻代晋升到了老年代。

本次GC用户耗时为user=0.02秒，内核耗时为sys=0.05秒，总耗时为real=0.02秒。

Full GC

```
1 2021-03-31T14:08:51.337-0800: 0.811: [Full GC (Ergonomics) [PSYoungGen: 20189K->0K(116736K)] [ParOldGen: 320188K->244171K(349696K)] 340377K->244171K(466432K), [Metaspace: 2706K->2706K(1056768K)], 0.0585233 secs] [Times: user=0.11 sys=0.01, real=0.06 secs]
```

FullGC发生在程序启动后的0.811s，新生代直接变成了0k，老年代，320188K->244171K = 76017k（74M）。Metaspace没有变化。总耗时为0.06。

Minor GC 仅仅年轻代区回收； Full GC 清理了不仅清理了年轻代对象（一般全部清理），还清理了老年代和Metaspace，所以Full GC的耗时远大与Minor GC。

3、CMS

```
2021-03-31T14:08:51.721-0800: 0.281: GC (Allocation Failure) [PSYoungGen: 121178K->21499K(153088K)] 131178K->48782K(502784K), 0.0203588 secs] [Times: user=0.02 sys=0.05, real=0.02 secs]
2021-03-31T14:08:51.788-0800: 0.272: GC (Allocation Failure) [PSYoungGen: 120800K->21499K(153088K)] 130800K->48642K(502784K), 0.0175238 secs] [Times: user=0.01 sys=0.05, real=0.06 secs]
2021-03-31T14:08:51.808-0800: 0.263: GC (Allocation Failure) [PSYoungGen: 121875K->21499K(153088K)] 228075K->122979K(502784K), 0.0199555 secs] [Times: user=0.01 sys=0.05, real=0.02 secs]
2021-03-31T14:08:51.854-0800: 0.426: GC (Allocation Failure) [PSYoungGen: 122626K->21499K(153088K)] 231726K->126231K(502784K), 0.0225162 secs] [Times: user=0.04 sys=0.05, real=0.02 secs]
2021-03-31T14:08:51.854-0800: 0.588: GC (Allocation Failure) [PSYoungGen: 123275K->21499K(153088K)] 236675K->128881K(502784K), 0.0205782 secs] [Times: user=0.04 sys=0.05, real=0.02 secs]
2021-03-31T14:08:51.114-0800: 0.584: GC (Allocation Failure) [PSYoungGen: 123100K->21499K(153088K)] 244410K->124934K(466432K), 0.0150258 secs] [Times: user=0.04 sys=0.05, real=0.02 secs]
2021-03-31T14:08:51.121-0800: 0.621: GC (Allocation Failure) [PSYoungGen: 100750K->10000K(157760K)] 100000K->56534K(466432K), 0.0174248 secs] [Times: user=0.04 sys=0.05, real=0.01 secs]
2021-03-31T14:08:51.135-0800: 0.639: GC (Allocation Failure) [PSYoungGen: 80000K->45073K(157760K)] 123800K->20104K(466432K), 0.0187528 secs] [Times: user=0.01 sys=0.05, real=0.02 secs]
2021-03-31T14:08:51.135-0800: 0.650: GC (Allocation Failure) [PSYoungGen: 80425K->57600K(157760K)] 140075K->20073K(466432K), 0.0182020 secs] [Times: user=0.01 sys=0.05, real=0.01 secs]
2021-03-31T14:08:51.135-0800: 0.811: Full GC (Ergonomics) [PSYoungGen: 20189K->0K(116736K)] [ParOldGen: 320188K->244171K(349696K)] 340377K->244171K(466432K), [Metaspace: 2706K->2706K(1056768K)], 0.0585233 secs] [Times: user=0.11 sys=0.01, real=0.06 secs]
2021-03-31T14:08:51.135-0800: 0.730: GC (Allocation Failure) [PSYoungGen: 121881K->21499K(157760K)] 242100K->122780K(466432K), 0.0121516 secs] [Times: user=0.04 sys=0.05, real=0.04 secs]
2021-03-31T14:08:51.135-0800: 0.784: GC (Allocation Failure) [PSYoungGen: 101400K->49000K(157760K)] 181320K->140579K(466432K), 0.0172773 secs] [Times: user=0.01 sys=0.05, real=0.03 secs]
2021-03-31T14:08:51.414-0800: 0.688: GC (Allocation Failure) [PSYoungGen: 101730K->22658K(157760K)] 202740K->26520K(466432K), 0.0055427 secs] [Times: user=0.02 sys=0.05, real=0.08 secs]
2021-03-31T14:08:51.414-0800: 0.692: GC (Allocation Failure) [PSYoungGen: 100540K->22658K(157760K)] 191580K->27771K(466432K), 0.0060238 secs] [Times: user=0.01 sys=0.05, real=0.01 secs]
2021-03-31T14:08:51.414-0800: 0.740: GC (Allocation Failure) [PSYoungGen: 101840K->22658K(157760K)] 192710K->27820K(466432K), 0.0060528 secs] [Times: user=0.01 sys=0.05, real=0.01 secs]
2021-03-31T14:08:51.564-0800: 0.677: GC (Allocation Failure) [PSYoungGen: 100830K->19958K(157760K)] 201540K->12330K(466432K), 0.0070445 secs] [Times: user=0.02 sys=0.05, real=0.01 secs]
2021-03-31T14:08:51.564-0800: 0.861: Full GC (Ergonomics) [PSYoungGen: 19958K->0K(116736K)] [ParOldGen: 100425K->10000K(349696K)] 210000K->17000K(466432K), [Metaspace: 2706K->2706K(1056768K)], 0.0460171 secs] [Times: user=0.10 sys=0.09, real=0.05 secs]
2021-03-31T14:08:51.567-0800: 1.062: GC (Allocation Failure) [PSYoungGen: 50880K->19958K(157760K)] 215400K->226476K(466432K), 0.0040438 secs] [Times: user=0.02 sys=0.05, real=0.01 secs]
最后一步，生成堆内存快照完成： 1578
Heap
PermGen total 156756K, used 48200K [400000000755888K, 0-0000000755888K, 0-0000000755888K]
From space 15680K, 34K used [0-0000000755888K, 0-0000000755888K, 0-0000000755888K]
To space 17650K, 0K used [0-0000000755888K, 0-0000000755888K, 0-0000000755888K]
Par Eden total 349640K, used 27604K [0-0000000755888K, 0-0000000755888K, 0-0000000755888K]
Eden space 349640K, 77K used [0-0000000755888K, 0-0000000755888K, 0-0000000755888K]
Survivor total 10000K, capacity 1000K, committed 512K, reserved 1048576K
Class space used 250K, capacity 380K, committed 512K, reserved 1048576K
cgc-0.0.0.0 heap ]
```

YOUNG GC

```
1 2021-03-31T14:38:29.775-0800: 0.229: [GC (Allocation Failure) 2021-03-31T14:38:29.775-0800: 0.229: [ParNew: 139776K->17471K(157248K), 0.0187305 secs] 139776K->41591K(506816K), 0.0188049 secs] [Times: user=0.02 sys=0.04, real=0.02 secs]
```

第一次GC发生时间在程序启动后的0.229秒，是一次Minor GC，并且发生原因是Allocation Failure。

本次Minor GC共回收掉了年轻代 139776K - 17471K = 122305（约120M）的容量。0.0187305 secs

同时堆内存从131178K - 48782K = 98185K（约96M）。122305K - 48782K = 24120（约24M），耗时为0.0188049 secs

本次总共有24M的数据从年轻代晋升到了老年代。

本次GC用户耗时为user=0.02秒，内核耗时为sys=0.04秒，总耗时为real=0.02秒。

# FULLGC

```
021-03-31T14:38:30.161-0800: 0.615: [GC (CMS Initial Mark) [1 CMS-initial-mark: 207070K(349568K)] 224706K(506816K), 0.0002498 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.161-0800: 0.615: [CMS-concurrent-mark-start]
021-03-31T14:38:30.166-0800: 0.620: [CMS-concurrent-mark: 0.005/0.005 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.166-0800: 0.620: [CMS-concurrent-preclean-start]
021-03-31T14:38:30.167-0800: 0.621: [CMS-concurrent-preclean: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.167-0800: 0.621: [CMS-concurrent-abortable-preclean-start]
021-03-31T14:38:30.384-0800: 0.802: [Allocation Failure] 2021-03-31T14:38:30.384-0800: 0.802: [PermGen: 157248K~157248K(157248K), 0.0002370 secs] 354373K~378013K(506816K), 0.0000266 secs] [Times: user=0.11 sys=0.02, real=0.04 secs]
021-03-31T14:38:30.384-0800: 0.758: [Allocation Failure] 2021-03-31T14:38:30.384-0800: 0.758: [PermGen: 157248K~157248K(157248K), 0.0338939 secs] 438938K~515806K(506816K), 0.0000002 secs] [Times: user=0.11 sys=0.02, real=0.03 secs]
021-03-31T14:38:30.384-0800: 0.830: [Allocation Failure] 2021-03-31T14:38:30.384-0800: 0.830: [PermGen: 157248K~157248K(157248K), 0.0020866 secs] 455572K~527353K(506816K), 0.0000200 secs] [Times: user=0.10 sys=0.02, real=0.00 secs]
021-03-31T14:38:30.426-0800: 0.881: [CMS-concurrent-abortable-preclean: 0.003/0.260 secs] [Times: user=0.46 sys=0.07, real=0.26 secs]
021-03-31T14:38:30.427-0800: 0.881: [GC (CMS Final Remark) [YG occupancy: 17614 K (157248 K)]2021-03-31T14:38:30.427-0800: 0.881: [Rescan (parallel) , 0.0005467 secs]2021-03-31T14:38:30.429-0800: 0.883: [weak refs processing, 0.0000625 s
cs]2021-03-31T14:38:30.429-0800: 0.883: [class unloading, 0.0011147 secs]2021-03-31T14:38:30.430-0800: 0.884: [scrub symbol table, 0.0015494 secs]2021-03-31T14:38:30.432-0800: 0.886: [scrub string table, 0.0001918 secs][1 CMS-remark: 339
810K(349568K)] 357425K(506816K), 0.0049177 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
021-03-31T14:38:30.432-0800: 0.886: [CMS-concurrent-sweep-start]
021-03-31T14:38:30.433-0800: 0.887: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.433-0800: 0.887: [CMS-concurrent-reset-start]
021-03-31T14:38:30.434-0800: 0.888: [CMS-concurrent-reset: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
```

1.Initial Mark(初始标记): 当前步骤需要JVM暂停STW, 标记的根对象用时0.0002498 secs 几乎没有任何停顿。

```
1 [GC (CMS Initial Mark) [1 CMS-initial-mark: 207070K(349568K)] 224706K(506816K), 0.0002498 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
```

2.并发标记。

```
1 2021-03-31T14:38:30.161-0800: 0.615: [CMS-concurrent-mark-start]
2 2021-03-31T14:38:30.166-0800: 0.620: [CMS-concurrent-mark: 0.005/0.005 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
```

3.并发预清理。

```
1 2021-03-31T14:38:30.166-0800: 0.620: [CMS-concurrent-preclean-start]
2 2021-03-31T14:38:30.167-0800: 0.621: [CMS-concurrent-preclean: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
3 2021-03-31T14:38:30.167-0800: 0.621: [CMS-concurrent-abortable-preclean-start]
4 2021-03-31T14:38:30.426-0800: 0.881: [CMS-concurrent-abortable-preclean: 0.003/0.260 secs] [Times: user=0.46 sys=0.07, real=0.26 secs]
```

4.最终标记。需要STW

```
1 2021-03-31T14:38:30.427-0800: 0.881: [GC (CMS Final Remark) [YG occupancy: 17614 K (157248 K)]2021-03-31T14:38:30.427-0800: 0.881: [Rescan (parallel) , 0.0016467 secs]2021-03-31T14:38:30.429-0800: 0.883: [weak refs processing, 0.0000625 secs]2021-03-31T14:38:30.429-0800: 0.883: [class unloading, 0.0011147 secs]2021-03-31T14:38:30.430-0800: 0.884: [scrub symbol table, 0.0015494 secs]2021-03-31T14:38:30.432-0800: 0.886: [scrub string table, 0.0001918 secs][1 CMS-remark: 339810K(349568K)] 357425K(506816K), 0.0049177 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
```

5.Concurrent Sweep(并发清除)

```
1 2021-03-31T14:38:30.432-0800: 0.886: [CMS-concurrent-sweep-start]
2 2021-03-31T14:38:30.433-0800: 0.887: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
```

6.并发重置

```
1 2021-03-31T14:38:30.433-0800: 0.887: [CMS-concurrent-reset-start]
```

```
2 2021-03-31T14:38:30.434-0800: 0.888: [CMS-concurrent-reset: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
```

CMS垃圾回收主要分为初始标记，并发标记，并发预清除，最终标记，并发清除，并发重置。仅在初始标记，最终标记会STW，且时间非常短。

值得注意的是在并发预清理的期间，发生了3次youngGC

```
021-03-31T14:38:30.161-0800: 0.615: [GC (CMS Initial Mark) [1 CMS-Initial-mark: 207070K(349568K)] 224786K(506816K), 0.0002498 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.161-0800: 0.615: [CMS-concurrent-mark-start]
021-03-31T14:38:30.166-0800: 0.620: [CMS-concurrent-mark: 0.005/0.005 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.166-0800: 0.620: [CMS-concurrent-preclean-start]
021-03-31T14:38:30.167-0800: 0.621: [CMS-concurrent-preclean: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.167-0800: 0.621: [CMS-concurrent-sweep-start]
021-03-31T14:38:30.208-0800: 0.662: [GC (Allocation Failure) 2021-03-31T14:38:30.208-0800: 0.662: [ParNew: 157280K->17470K(157248K), 0.0402270 secs] 364277K
021-03-31T14:38:30.304-0800: 0.758: [GC (Allocation Failure) 2021-03-31T14:38:30.304-0800: 0.758: [ParNew: 157248K->17472K(157248K), 0.0338939 secs] 418591K
021-03-31T14:38:30.304-0800: 0.838: [GC (Allocation Failure) 2021-03-31T14:38:30.304-0800: 0.838: [ParNew: 157248K->17470K(157248K), 0.0424866 secs] 455672K
021-03-31T14:38:30.426-0800: 0.881: [CMS-concurrent-abort-terminate-preclean: 0.00378-200 secs] [Times: user=0.00 sys=0.07, real=0.26 secs]
021-03-31T14:38:30.427-0800: 0.881: [GC (CMS Final Remark) [YG occupancy: 17614 K (157248 K)] 2021-03-31T14:38:30.427-0800: 0.881: [Rescan (parallel) , 0.001
csl2021-03-31T14:38:30.429-0800: 0.883: [class unloading, 0.001147 secs] 2021-03-31T14:38:30.430-0800: 0.884: [scrub symbol table, 0.0015404 secs] 2021-03-31
18K(349568K)] 357425K(506816K), 0.0049177 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
021-03-31T14:38:30.432-0800: 0.886: [CMS-concurrent-sweep-start]
021-03-31T14:38:30.433-0800: 0.887: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.433-0800: 0.887: [CMS-concurrent-reset-start]
021-03-31T14:38:30.434-0800: 0.888: [CMS-concurrent-reset: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.470-0800: 0.924: [GC (Allocation Failure) 2021-03-31T14:38:30.470-0800: 0.924: [ParNew: 157164K->17470K(157248K), 0.0262962 secs] 454180K
021-03-31T14:38:30.497-0800: 0.951: [GC (CMS Initial Mark) [1 CMS-Initial-mark: 340860K(349568K)] 358474K(506816K), 0.0001453 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
021-03-31T14:38:30.497-0800: 0.951: [CMS-concurrent-mark-start]
```

## 4、G1GC

### Minor GC

```
1 2021-03-31T15:56:47.128-0800: 0.198: [GC pause (G1 Evacuation Pause) (young),
0.0092168 secs]
2 [Parallel Time: 8.7 ms, GC Workers: 4]
3 [GC Worker Start (ms): Min: 198.5, Avg: 199.0, Max: 200.3, Diff: 1.7]
4 [Ext Root Scanning (ms): Min: 0.0, Avg: 0.6, Max: 1.4, Diff: 1.4, Sum: 2.3]
5 [Update RS (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
6 [Processed Buffers: Min: 0, Avg: 0.0, Max: 0, Diff: 0, Sum: 0]
7 [Scan RS (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
8 [Code Root Scanning (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
9 [Object Copy (ms): Min: 5.9, Avg: 6.8, Max: 7.4, Diff: 1.5, Sum: 27.3]
10 [Termination (ms): Min: 0.0, Avg: 0.7, Max: 1.1, Diff: 1.1, Sum: 2.9]
11 [Termination Attempts: Min: 1, Avg: 1.0, Max: 1, Diff: 0, Sum: 4]
12 [GC Worker Other (ms): Min: 0.0, Avg: 0.0, Max: 0.1, Diff: 0.0, Sum: 0.1]
13 [GC Worker Total (ms): Min: 6.9, Avg: 8.1, Max: 8.6, Diff: 1.7, Sum: 32.6]
14 [GC Worker End (ms): Min: 207.1, Avg: 207.2, Max: 207.2, Diff: 0.0]
15 [Code Root Fixup: 0.0 ms]
16 [Code Root Purge: 0.0 ms]
17 [Clear CT: 0.0 ms]
18 [Other: 0.5 ms]
19 [Choose CSet: 0.0 ms]
20 [Ref Proc: 0.2 ms]
21 [Ref Enq: 0.0 ms]
22 [Redirty Cards: 0.0 ms]
23 [Humongous Register: 0.1 ms]
24 [Humongous Reclaim: 0.0 ms]
25 [Free CSet: 0.0 ms]
26 [Eden: 25.0M(25.0M)->0.0B(21.0M) Survivors: 0.0B->4096.0K Heap: 35.5M(512.0M)-
>13.7M(512.0M)]
27 [Times: user=0.01 sys=0.00, real=0.01 secs]
```

日志分析：

```
1 2021-03-31T15:56:47.128-0800: 0.198: [GC pause (G1 Evacuation Pause) (young),
0.0092168 secs]
```

发生在程序启动后的0.198秒，只执行了young区回收，耗时0.0092168 秒。STW时间0.0092168秒。

1	[Parallel Time: 8.7 ms, GC Workers: 4]
---	--

GC线程为4个，时间为8.7ms

1	GC Worker Start (ms): Min: 198.5, Avg: 199.0, Max: 200.3, Diff: 1.7]
---	--

GC线程工作的启动时间（相对JVM的启动时间），如果Min与Max相差较大，说明有其他线程抢占CPU资源

1	[Ext Root Scanning (ms): Min: 0.0, Avg: 0.6, Max: 1.4, Diff: 1.4, Sum: 2.3]
---	---

扫描对外内存的时间

1	[Update RS (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
---	---

线程更新remember set的时间

1	[Processed Buffers: Min: 0, Avg: 0.0, Max: 0, Diff: 0, Sum: 0]
2	[Scan RS (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]

扫描CSet中的region对应的RSet的时间。

1	[Code Root Scanning (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
---	--

扫描实际代码中Root的时间

1	[Object Copy (ms): Min: 5.9, Avg: 6.8, Max: 7.4, Diff: 1.5, Sum: 27.3]
---	--

拷贝回收集中的对象用时

1	[Termination (ms): Min: 0.0, Avg: 0.7, Max: 1.1, Diff: 1.1, Sum: 2.9]
---	---

确认GC线程可以终止的耗时

1	[Termination Attempts: Min: 1, Avg: 1.0, Max: 1, Diff: 0, Sum: 4]
---	---

有多少GC线程尝试中止

1	[GC Worker Other (ms): Min: 0.0, Avg: 0.0, Max: 0.1, Diff: 0.0, Sum: 0.1]
---	---

其他任务的耗时。

1	[GC Worker Total (ms): Min: 6.9, Avg: 8.1, Max: 8.6, Diff: 1.7, Sum: 32.6]
---	--

GC线程总耗时。

1	[GC Worker End (ms): Min: 207.1, Avg: 207.2, Max: 207.2, Diff: 0.0]
---	---

GC作业完成时刻。

1	[Code Root Fixup: 0.0 ms]
---	---------------------------

释放用于管理并行活动的内部数据时间

1	[Code Root Purge: 0.0 ms]
---	---------------------------

请求其他部分数据时间

1	[Clear CT: 0.0 ms]
1	[Other: 0.5 ms]

其他活动耗时

1	[Choose CSet: 0.0 ms]、
---	------------------------

选择CSet的耗时时间

1	[Ref Proc: 0.2 ms]
---	--------------------

处理非强引用的时间

1	[Ref Enq: 0.0 ms]
2	[Redirty Cards: 0.0 ms]
3	[Humongous Register: 0.1 ms]
4	[Humongous Reclaim: 0.0 ms]
1	[Free CSet: 0.0 ms]

释放regions的时间。

--	--

```
1 [Eden: 25.0M(25.0M)->0.0B(21.0M) Survivors: 0.0B->4096.0K
2 Heap: 35.5M(512.0M)->13.7M(512.0M)]
```

Eden区GC使用前后大小 25.0M(25.0M)->0.0B(21.0M)。Survivors区GC 前后的使用: 0.0B->4096.0K。暂停前后整个堆内存使用总量。

```
1 [Times: user=0.01 sys=0.00, real=0.01 secs]
```

GC时间的持续时间。0.01秒

## Full GC

日志:

```
1 2021-03-31T15:56:47.714-0800: 0.784: [GC pause (G1 Humongous Allocation) (young)
  (initial-mark), 0.0048943 secs]
2   [Parallel Time: 4.5 ms, GC Workers: 4]
3     [GC Worker Start (ms): Min: 784.2, Avg: 784.3, Max: 784.4, Diff: 0.2]
4     [Ext Root Scanning (ms): Min: 0.0, Avg: 0.1, Max: 0.2, Diff: 0.2, Sum: 0.6]
5     [Update RS (ms): Min: 0.1, Avg: 0.1, Max: 0.1, Diff: 0.0, Sum: 0.6]
6     [Processed Buffers: Min: 1, Avg: 2.5, Max: 4, Diff: 3, Sum: 10]
7     [Scan RS (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
8     [Code Root Scanning (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
9     [Object Copy (ms): Min: 4.0, Avg: 4.0, Max: 4.0, Diff: 0.1, Sum: 16.0]
10    [Termination (ms): Min: 0.0, Avg: 0.1, Max: 0.1, Diff: 0.1, Sum: 0.2]
11    [Termination Attempts: Min: 1, Avg: 1.0, Max: 1, Diff: 0, Sum: 4]
12    [GC Worker Other (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.1]
13    [GC Worker Total (ms): Min: 4.2, Avg: 4.3, Max: 4.4, Diff: 0.2, Sum: 17.4]
14    [GC Worker End (ms): Min: 788.6, Avg: 788.7, Max: 788.7, Diff: 0.0]
15    [Code Root Fixup: 0.0 ms]
16    [Code Root Purge: 0.0 ms]
17    [Clear CT: 0.0 ms]
18    [Other: 0.4 ms]
19      [Choose CSet: 0.0 ms]
20      [Ref Proc: 0.1 ms]
21      [Ref Enq: 0.0 ms]
22      [Redirty Cards: 0.0 ms]
23      [Humongous Register: 0.1 ms]
24      [Humongous Reclaim: 0.0 ms]
25      [Free CSet: 0.0 ms]
26    [Eden: 3072.0K(55.0M)->0.0B(54.0M) Survivors: 20.0M->2048.0K Heap: 360.4M(512.0M)-
    >359.8M(512.0M)]
27    [Times: user=0.01 sys=0.01, real=0.00 secs]
28 2021-03-31T15:56:47.719-0800: 0.789: [GC concurrent-root-region-scan-start]
29 2021-03-31T15:56:47.719-0800: 0.789: [GC concurrent-root-region-scan-end, 0.0001759
    secs]
30 2021-03-31T15:56:47.719-0800: 0.789: [GC concurrent-mark-start]
31 2021-03-31T15:56:47.724-0800: 0.795: [GC concurrent-mark-end, 0.0054434 secs]
32 2021-03-31T15:56:47.725-0800: 0.795: [GC remark 2021-03-31T15:56:47.725-0800: 0.795:
    [Finalize Marking, 0.0002283 secs] 2021-03-31T15:56:47.725-0800: 0.795: [GC ref-proc,
    0.0000430 secs] 2021-03-31T15:56:47.725-0800: 0.795: [Unloading, 0.0008065 secs],
    0.0018361 secs]
33    [Times: user=0.01 sys=0.00, real=0.00 secs]
34 2021-03-31T15:56:47.727-0800: 0.797: [GC cleanup 373M->373M(512M), 0.0005796 secs]
```

```
35 [Times: user=0.00 sys=0.00, real=0.00 secs]
```

## 上一次youngGC

```
1 [Eden: 300.0M(300.0M)->0.0B(55.0M) Survivors: 7168.0K->20.0M Heap: 440.8M(512.0M)->358.0M(512.0M)]
```

显示分配的Yong 区将要耗尽，在次Minor GC耗时0.014s,之后紧接着 发生了G1的并发标记清理垃圾。对空间的使用量  $69.9\% = 358M/512.0M$ 。

第一阶段：initial-mark，初始标记[Times: user=0.01 sys=0.01, real=0.00 secs]，耗时0.0048943 secs 发生STW

第二阶段：concurrent-root-region-scan，从root regions中扫存活对象

第三阶段：GC concurrent-mark-并发标记，递归扫描整个堆里的对象图，找出要回收的对象，但可与用户程序并发执行。

第四阶段：remark，对用户线程做另一个短暂的暂停，用于处理并发阶段结束后仍遗留下来的最后那少量的SATB记录。

第五阶段：cleanup;这一阶段主要为接下来即将要进行的对象转移阶段做准备。统计出所有小堆区中的存活对象，并且对这些小堆区按存活对象数进行排序。也为下一次标记阶段作必要的整理工作。

```
1 [Times: user=0.00 sys=0.00, real=0.00 secs]
```

该阶段耗时