gc日志分析

serial收集器
-XX:+UseSerialGC -Xms512m -Xmx512m -Xmn256m -XX:+PrintGCDetails -XX:+PrintGCTimeStamps -Xloggc:gc_analysis.log -XX:MetaspaceSize=128m -XX:MaxMetaspaceSize=256m

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Java HotSpot(TM) 64-Bit Server VM (25.201-b09) for bsd-amd64 JRE (1.8.0_201-b09), built on Dec 15 2018 18:35:23 by "java_re" with gcc 4.2.1 (Based on Apple Inc. build 5658) (LLVM build 2336.11.00)
Memory: 4k page, physical 8388608k(167396k free)

/proc/meminfo:

CommandLine flags: -XX:CompressedClassSpaceSize=260046848 -XX:InitialHeapSize=536870912 -XX:MaxHeapSize=536870912 -XX:MaxMetaspaceSize=268435456 -XX:MaxNewSize=268435456 -XX:MetaspaceSize=134217728 -XX:NewSize=268435456 -XX:+PrintGC -XX:+PrintGCDetails -XX:+PrintGCTimeStamps -XX:+UseCompressedClassPointers -XX:+UseCompressedOops -XX:+UseSerialGC
13.931: [GC (Allocation Failure) 13.931: [DefNew: 209792K->26175K(235968K), 0.1694686 secs] 209792K->51481K(498112K), 0.1696257 secs] [Times: user=0.06 sys=0.06, real=0.17 secs]
23.618: [GC (Allocation Failure) 23.619: [DefNew: 235967K->26176K(235968K), 0.3445131 secs] 261273K->120745K(498112K), 0.3451929 secs] [Times: user=0.10 sys=0.13, real=0.35 secs]
33.308: [GC (Allocation Failure) 33.309: [DefNew: 235948K->26176K(235968K), 0.3134347 secs] 330518K->182493K(498112K), 0.3154654 secs] [Times: user=0.09 sys=0.08, real=0.32 secs]
43.137: [GC (Allocation Failure) 43.143: [DefNew: 235968K->26175K(235968K), 0.3496455 secs] 392285K->244255K(498112K), 0.3597672 secs] [Times: user=0.08 sys=0.10, real=0.36 secs]
53.042: [GC (Allocation Failure) 53.044: [DefNew: 235967K->235967K(235968K), 0.0001920 secs]53.044: [Tenured: 218079K->250934K(262144K), 0.6647018 secs] 454047K->250934K(498112K), [Metaspace: 7538K->7538K(1056768K)], 0.6676237 secs] [Times: user=0.24 sys=0.11, real=0.66 secs]
62.785: [GC (Allocation Failure) 62.785: [DefNew: 209792K->209792K(235968K), 0.0000646 secs]62.785: [Tenured: 250934K->261958K(262144K), 0.3462673 secs] 460726K->276868K(498112K), [Metaspace: 7538K->7538K(1056768K)], 0.3523584 secs] [Times: user=0.20 sys=0.02, real=0.35 secs]
73.114: [Full GC (Allocation Failure) 73.122: [Tenured: 261958K->261797K(262144K), 0.2889074 secs] 497840K->292792K(498112K), [Metaspace: 7538K->7538K(1056768K)], 0.2974231 secs] [Times: user=0.14 sys=0.01, real=0.30 secs]
82.583: [Full GC (Allocation Failure) 82.583: [Tenured: 262049K->262108K(262144K), 0.3721346 secs] 497989K->299271K(498112K), [Metaspace: 7538K->7538K(1056768K)], 0.3726562 secs] [Times: user=0.23 sys=0.01, real=0.37 secs]
91.213: [Full GC (Allocation Failure) 91.214: [Tenured: 262108K->261455K(262144K), 0.3409603 secs] 497878K->323794K(498112K), [Metaspace: 7538K->7538K(1056768K)], 0.3424459 secs] [Times: user=0.15 sys=0.00, real=0.34 secs]

Heap
 def new generation   total 235968K, used 142363K [0x00000007d0800000, 0x00000007e0800000, 0x00000007e0800000)
  eden space 209792K,  67% used [0x00000007d0800000, 0x00000007d9306fa0, 0x00000007dd4e0000)
  from space 26176K,   0% used [0x00000007dd4e0000, 0x00000007dd4e0000, 0x00000007dee70000)
  to   space 26176K,   0% used [0x00000007dee70000, 0x00000007dee70000, 0x00000007e0800000)
 tenured generation   total 262144K, used 261804K [0x00000007e0800000, 0x00000007f0800000, 0x00000007f0800000)
   the space 262144K,  99% used [0x00000007e0800000, 0x00000007f07ab210, 0x00000007f07ab400, 0x00000007f0800000)
 Metaspace       used 3651K, capacity 4540K, committed 4864K, reserved 1056768K
  class space    used 407K, capacity 428K, committed 512K, reserved 1048576K
```

eden：209792K，from：26176K，to：26176K，old：262144K
young容量=eden+from。13.931s发生第1次gc(young gc)，eden快满时触发，耗时0.17s，young占用从209792K降低至

26175K，heap大小变为51484K，说明to被填满，剩下存活对象的直接进入old；53.042s，old可用空间小于晋升平均大小，触发full gc，eden和from的存活对象进入old；62.785s类似，但不包括from；73.114s，old已满，eden已满继续在from分配，from快满时触发full gc，存活对象进入old。

ParNew收集器
Java11参数-XX:+UseParallelGC -Xms512m -Xmx512m -Xmn256m -XX:MetaspaceSize=128m -XX:MaxMetaspaceSize=256m -Xlog:gc=trace:file=gc_analysis.log:time,level,tags
Java8参数-XX:+UseParallelGC -Xms512m -Xmx512m -Xmn256m -XX:+PrintGCDetails -XX:+PrintGCTimeStamps -Xloggc:gc_analysis.log -XX:MetaspaceSize=128m -XX:MaxMetaspaceSize=256m

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1.  Java HotSpot(TM) 64-Bit Server VM (25.201-b09) for bsd-amd64 JRE (1.8.0_201-b09), built on Dec 15 201
    8 18:35:23 by "java_re" with gcc 4.2.1 (Based on Apple Inc. build 5658) (LLVM build 2336.11.00)
2.  Memory: 4k page, physical 8388608k(1649036k free)
3.
4.  /proc/meminfo:
5.
6.  CommandLine flags: -XX:CompressedClassSpaceSize=260046848 -XX:InitialHeapSize=536870912 -XX:
    MaxHeapSize=536870912 -XX:MaxMetaspaceSize=268435456 -XX:MaxNewSize=268435456 -XX:Metas
    paceSize=134217728 -XX:NewSize=268435456 -XX:+PrintGC -XX:+PrintGCDetails -XX:+PrintGCTimeSta
    mps -XX:+UseCompressedClassPointers -XX:+UseCompressedOops -XX:+UseParallelGC
7.  8.028: [GC (Allocation Failure) [PSYoungGen: 196608K->32749K(229376K)] 196608K->60795K(491520
    K), 0.0314279 secs] [Times: user=0.03 sys=0.07, real=0.03 secs]
8.  16.660: [GC (Allocation Failure) [PSYoungGen: 229357K->32761K(229376K)] 257403K->117032K(4915
    20K), 0.0367215 secs] [Times: user=0.04 sys=0.08, real=0.04 secs]
9.  25.195: [GC (Allocation Failure) [PSYoungGen: 229369K->32766K(229376K)] 313640K->170586K(4915
    20K), 0.0498591 secs] [Times: user=0.07 sys=0.05, real=0.05 secs]
10. 33.343: [GC (Allocation Failure) [PSYoungGen: 229374K->32759K(229376K)] 367194K->220439K(4915
    20K), 0.0244918 secs] [Times: user=0.04 sys=0.04, real=0.03 secs]
11. 41.923: [GC (Allocation Failure) [PSYoungGen: 229367K->32761K(224768K)] 417047K->278156K(4869
    12K), 0.0294736 secs] [Times: user=0.05 sys=0.05, real=0.03 secs]
12. 41.952: [Full GC (Ergonomics) [PSYoungGen: 32761K->0K(224768K)] [ParOldGen: 245394K->219747K(2
    62144K)] 278156K->219747K(486912K), [Metaspace: 3768K->3768K(1056768K)], 0.0413142 secs] [Ti
    mes: user=0.11 sys=0.01, real=0.04 secs]
13. 50.056: [Full GC (Ergonomics) [PSYoungGen: 192000K->0K(224768K)] [ParOldGen: 219747K->251937K(
    262144K)] 411747K->251937K(486912K), [Metaspace: 3768K->3768K(1056768K)], 0.0414604 secs] [Ti
    mes: user=0.10 sys=0.01, real=0.04 secs]
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gc用时明显低于serial gc，前5次为普通young gc，后面的full gc标注Ergonomics，说明是启发式的，垃圾收集器预测old可用空间可能不足，触发full gc，比较特别的是紧接着最后一次minor gc触发了full gc，这次full gc在young区只回收了s1。

CMS收集器
-XX:+UseConcMarkSweepGC -Xms512m -Xmx512m -Xmn256m -XX:+PrintGCDetails -XX:+PrintGCTimeStamps -Xloggc:gc_analysis.log -XX:MetaspaceSize=128m -XX:MaxMetaspaceSize=256m

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1.  Java HotSpot(TM) 64-Bit Server VM (25.201-b09) for bsd-amd64 JRE (1.8.0_201-b09), built on Dec 15 201
    8 18:35:23 by "java_re" with gcc 4.2.1 (Based on Apple Inc. build 5658) (LLVM build 2336.11.00)
2.  Memory: 4k page, physical 8388608k(871848k free)
3.
4.  /proc/meminfo:
5.
6.  CommandLine flags: -XX:CompressedClassSpaceSize=260046848 -XX:InitialHeapSize=536870912 -XX:
    MaxHeapSize=536870912 -XX:MaxMetaspaceSize=268435456 -XX:MaxNewSize=268435456 -XX:MaxT
    enuringThreshold=6 -XX:MetaspaceSize=134217728 -XX:NewSize=268435456 -XX:OldPLABSize=16 -X
    X:+PrintGC -XX:+PrintGCDetails -XX:+PrintGCTimeStamps -XX:+UseCompressedClassPointers -XX:+Use
    CompressedOops -XX:+UseConcMarkSweepGC -XX:+UseParNewGC
7.  9.442: [GC (Allocation Failure) 9.442: [ParNew: 209792K->26176K(235968K), 0.0312153 secs] 209792K-
    >63591K(498112K), 0.0314015 secs] [Times: user=0.04 sys=0.07, real=0.03 secs]
8.  19.122: [GC (Allocation Failure) 19.125: [ParNew: 235968K->26176K(235968K), 0.0609070 secs] 27338
    3K->127040K(498112K), 0.0644059 secs] [Times: user=0.07 sys=0.11, real=0.06 secs]
9.  29.086: [GC (Allocation Failure) 29.086: [ParNew: 235968K->26175K(235968K), 0.0587913 secs] 33683
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2K->188895K(498112K), 0.0589185 secs] [Times: user=0.20 sys=0.03, real=0.06 secs]
29.145: [GC (CMS Initial Mark) [1 CMS-initial-mark: 162720K(262144K)] 189150K(498112K), 0.0002295 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
29.145: [CMS-concurrent-mark-start]
29.150: [CMS-concurrent-mark: 0.004/0.004 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
29.150: [CMS-concurrent-preclean-start]
29.150: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
29.150: [GC (CMS Final Remark) [YG occupancy: 26430 K (235968 K)]29.150: [Rescan (parallel) , 0.0002749 secs]29.150: [weak refs processing, 0.0000658 secs]29.151: [class unloading, 0.0004479 secs]29.151: [scrub symbol table, 0.0005410 secs]29.152: [scrub string table, 0.0001765 secs][1 CMS-remark: 162720K(262144K)] 189150K(498112K), 0.0016414 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
29.152: [CMS-concurrent-sweep-start]
29.152: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
29.152: [CMS-concurrent-reset-start]
29.153: [CMS-concurrent-reset: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
31.157: [GC (CMS Initial Mark) [1 CMS-initial-mark: 139147K(262144K)] 212289K(498112K), 0.0003771 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
31.158: [CMS-concurrent-mark-start]
31.162: [CMS-concurrent-mark: 0.004/0.004 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]
31.162: [CMS-concurrent-preclean-start]
31.162: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
31.162: [CMS-concurrent-abortable-preclean-start]
 CMS: abort preclean due to time 36.189: [CMS-concurrent-abortable-preclean: 0.052/5.026 secs] [Times: user=0.12 sys=0.02, real=5.02 secs]
36.189: [GC (CMS Final Remark) [YG occupancy: 180315 K (235968 K)]36.189: [Rescan (parallel) , 0.0006225 secs]36.190: [weak refs processing, 0.0001062 secs]36.190: [class unloading, 0.0003662 secs]36.190: [scrub symbol table, 0.0005174 secs]36.191: [scrub string table, 0.0003208 secs][1 CMS-remark: 139147K(262144K)] 319462K(498112K), 0.0021462 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
36.191: [CMS-concurrent-sweep-start]
36.192: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
36.192: [CMS-concurrent-reset-start]
36.192: [CMS-concurrent-reset: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
38.195: [GC (CMS Initial Mark) [1 CMS-initial-mark: 133322K(262144K)] 361169K(498112K), 0.0005474 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
38.195: [CMS-concurrent-mark-start]
38.199: [CMS-concurrent-mark: 0.004/0.004 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
38.199: [CMS-concurrent-preclean-start]
38.200: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
38.200: [CMS-concurrent-abortable-preclean-start]
38.625: [GC (Allocation Failure) 38.625: [ParNew: 235967K->26176K(235968K), 0.0369637 secs] 369289K->221183K(498112K), 0.0370986 secs] [Times: user=0.12 sys=0.01, real=0.04 secs]
40.527: [CMS-concurrent-abortable-preclean: 0.022/2.327 secs] [Times: user=0.16 sys=0.03, real=2.33 secs]
40.527: [GC (CMS Final Remark) [YG occupancy: 69396 K (235968 K)]40.527: [Rescan (parallel) , 0.0005421 secs]40.528: [weak refs processing, 0.0001007 secs]40.528: [class unloading, 0.0003914 secs]40.528: [scrub symbol table, 0.0006997 secs]40.529: [scrub string table, 0.0003247 secs][1 CMS-remark: 195007K(262144K)] 264403K(498112K), 0.0022460 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
40.530: [CMS-concurrent-sweep-start]
40.531: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
40.531: [CMS-concurrent-reset-start]
40.531: [CMS-concurrent-reset: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
42.535: [GC (CMS Initial Mark) [1 CMS-initial-mark: 173564K(262144K)] 292261K(498112K), 0.0004032 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
42.536: [CMS-concurrent-mark-start]
42.540: [CMS-concurrent-mark: 0.004/0.004 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]
42.540: [CMS-concurrent-preclean-start]
42.540: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
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42.540: [CMS-concurrent-abortable-preclean-start]
 CMS: abort preclean due to time 47.616: [CMS-concurrent-abortable-preclean: 0.048/5.075 secs] [Times: user=0.11 sys=0.02, real=5.07 secs]
47.616: [GC (CMS Final Remark) [YG occupancy: 232135 K (235968 K)]47.617: [Rescan (parallel) , 0.0010918 secs]47.618: [weak refs processing, 0.0001822 secs]47.618: [class unloading, 0.0012952 secs]47.619: [scrub symbol table, 0.0011271 secs]47.621: [scrub string table, 0.0001725 secs][1 CMS-remark: 173564K(262144K)] 405699K(498112K), 0.0043586 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]
47.621: [CMS-concurrent-sweep-start]
47.622: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
47.622: [CMS-concurrent-reset-start]
47.622: [CMS-concurrent-reset: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
47.861: [GC (Allocation Failure) 47.861: [ParNew: 235968K->26176K(235968K), 0.0345824 secs] 392403K->250484K(498112K), 0.0346934 secs] [Times: user=0.12 sys=0.02, real=0.03 secs]
47.896: [GC (CMS Initial Mark) [1 CMS-initial-mark: 224308K(262144K)] 250772K(498112K), 0.0001215 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
47.896: [CMS-concurrent-mark-start]
47.898: [CMS-concurrent-mark: 0.002/0.002 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
47.898: [CMS-concurrent-preclean-start]
47.899: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
47.899: [CMS-concurrent-abortable-preclean-start]
48.312: [CMS-concurrent-abortable-preclean: 0.003/0.414 secs] [Times: user=0.01 sys=0.00, real=0.42 secs]
48.313: [GC (CMS Final Remark) [YG occupancy: 39593 K (235968 K)]48.313: [Rescan (parallel) , 0.0005692 secs]48.314: [weak refs processing, 0.0000641 secs]48.314: [class unloading, 0.0003269 secs]48.314: [scrub symbol table, 0.0003389 secs]48.314: [scrub string table, 0.0002507 secs][1 CMS-remark: 224308K(262144K)] 263901K(498112K), 0.0017841 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
48.315: [CMS-concurrent-sweep-start]
48.317: [CMS-concurrent-sweep: 0.002/0.002 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
48.317: [CMS-concurrent-reset-start]
48.320: [CMS-concurrent-reset: 0.003/0.003 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
50.324: [GC (CMS Initial Mark) [1 CMS-initial-mark: 206869K(262144K)] 284629K(498112K), 0.0003704 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
50.325: [CMS-concurrent-mark-start]
50.329: [CMS-concurrent-mark: 0.004/0.004 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
50.329: [CMS-concurrent-preclean-start]
50.329: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
50.329: [CMS-concurrent-abortable-preclean-start]
50.329: [CMS-concurrent-abortable-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
50.330: [GC (CMS Final Remark) [YG occupancy: 77759 K (235968 K)]50.330: [Rescan (parallel) , 0.0003229 secs]50.330: [weak refs processing, 0.0000628 secs]50.330: [class unloading, 0.0002477 secs]50.330: [scrub symbol table, 0.0003469 secs]50.331: [scrub string table, 0.0001910 secs][1 CMS-remark: 206869K(262144K)] 284629K(498112K), 0.0012706 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
50.331: [CMS-concurrent-sweep-start]
50.332: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
50.332: [CMS-concurrent-reset-start]
50.332: [CMS-concurrent-reset: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
52.335: [GC (CMS Initial Mark) [1 CMS-initial-mark: 199368K(262144K)] 328088K(498112K), 0.0002050 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
52.335: [CMS-concurrent-mark-start]
52.337: [CMS-concurrent-mark: 0.002/0.002 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
52.337: [CMS-concurrent-preclean-start]
52.338: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
52.338: [CMS-concurrent-abortable-preclean-start]
52.338: [CMS-concurrent-abortable-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
52.338: [GC (CMS Final Remark) [YG occupancy: 128720 K (235968 K)]52.338: [Rescan (parallel) , 0.000
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3478 secs]52.338: [weak refs processing, 0.0000645 secs]52.338: [class unloading, 0.0004053 secs]52.
339: [scrub symbol table, 0.0003655 secs]52.339: [scrub string table, 0.0001696 secs][1 CMS-remark: 1
99368K(262144K)] 328088K(498112K), 0.0014969 secs] [Times: user=0.00 sys=0.01, real=0.00 secs]
52.339: [CMS-concurrent-sweep-start]
52.340: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
52.340: [CMS-concurrent-reset-start]
52.340: [CMS-concurrent-reset: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
54.343: [GC (CMS Initial Mark) [1 CMS-initial-mark: 192244K(262144K)] 360252K(498112K), 0.0003716
secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
54.344: [CMS-concurrent-mark-start]
54.347: [CMS-concurrent-mark: 0.004/0.004 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
54.347: [CMS-concurrent-preclean-start]
54.348: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
54.348: [CMS-concurrent-abortable-preclean-start]
54.348: [CMS-concurrent-abortable-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00
secs]
54.348: [GC (CMS Final Remark) [YG occupancy: 168007 K (235968 K)]54.348: [Rescan (parallel) , 0.000
4211 secs]54.348: [weak refs processing, 0.0000645 secs]54.349: [class unloading, 0.0002477 secs]54.
349: [scrub symbol table, 0.0003452 secs]54.349: [scrub string table, 0.0001912 secs][1 CMS-remark: 1
92244K(262144K)] 360252K(498112K), 0.0013949 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
54.349: [CMS-concurrent-sweep-start]
54.350: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
54.350: [CMS-concurrent-reset-start]
54.350: [CMS-concurrent-reset: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
56.352: [GC (CMS Initial Mark) [1 CMS-initial-mark: 184255K(262144K)] 395213K(498112K), 0.0004533
secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
56.353: [CMS-concurrent-mark-start]
56.356: [CMS-concurrent-mark: 0.003/0.003 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
56.356: [CMS-concurrent-preclean-start]
56.357: [CMS-concurrent-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
56.357: [CMS-concurrent-abortable-preclean-start]
57.457: [GC (Allocation Failure) 57.457: [ParNew57.496: [CMS-concurrent-abortable-preclean: 0.011/1.1
39 secs] [Times: user=0.14 sys=0.02, real=1.14 secs]
: 235633K->26176K(235968K), 0.0389827 secs] 419889K->274954K(498112K), 0.0390942 secs] [Time
s: user=0.12 sys=0.01, real=0.04 secs]
57.496: [GC (CMS Final Remark) [YG occupancy: 26847 K (235968 K)]57.496: [Rescan (parallel) , 0.0004
458 secs]57.497: [weak refs processing, 0.0000828 secs]57.497: [class unloading, 0.0004566 secs]57.4
98: [scrub symbol table, 0.0018124 secs]57.500: [scrub string table, 0.0003383 secs][1 CMS-remark: 24
8778K(262144K)] 275625K(498112K), 0.0037430 secs] [Times: user=0.00 sys=0.00, real=0.01 secs]
57.500: [CMS-concurrent-sweep-start]
57.502: [CMS-concurrent-sweep: 0.001/0.001 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
57.502: [CMS-concurrent-reset-start]
57.502: [CMS-concurrent-reset: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
Heap
 par new generation   total 235968K, used 79061K [0x00000007d0800000, 0x00000007e0800000, 0x00
000007e0800000)
  eden space 209792K,  25% used [0x00000007d0800000, 0x00000007d3ba5760, 0x00000007dd4e000
0)
  from space 26176K, 100% used [0x00000007dd4e0000, 0x00000007dee70000, 0x00000007dee70000
)
  to   space 26176K,   0% used [0x00000007dee70000, 0x00000007dee70000, 0x00000007e0800000)
 concurrent mark-sweep generation total 262144K, used 239876K [0x00000007e0800000, 0x00000007f
0800000, 0x00000007f0800000)
 Metaspace       used 3372K, capacity 4556K, committed 4864K, reserved 1056768K
  class space    used 371K, capacity 392K, committed 512K, reserved 1048576K
```

新生代使用ParNew收集器，可以看到初始标记，并发标记，并发预清理，可中断的并发预清理，最终标记，并发清理，并发重置等阶段，其

中初始标记和最终标记需要stw。进入预清理阶段时，若eden使用率低于10%则启动sample_eden，后续eden使用率达到50%时结束可中断的预清理阶段，目的是把都要stw的young gc和remark分开，降低停顿。若进入可中断的预清理阶段时eden使用率小于2M则直接结束，可能是因为这种情况下remark扫描young区的范围已经足够小了。其余退出可中断的预清理阶段的原因有用时超过5s(31.162s的可中断预清理)，超过循环次数(默认不限制)，老年代连续可用空间大小低于历次晋升平均值(38.625s在可中断的预清理期间发生young gc之后)。

G1收集器
-XX:+UseG1GC -Xms512m -Xmx512m -XX:+PrintGCTimeStamps -Xloggc:gc_analysis.log -XX:MetaspaceSize=128m -XX:MaxMetaspaceSize=256m

```
Java HotSpot(TM) 64-Bit Server VM (25.201-b09) for bsd-amd64 JRE (1.8.0_201-b09), built on Dec 15 2018 18:35:23 by "java_re" with gcc 4.2.1 (Based on Apple Inc. build 5658) (LLVM build 2336.11.00)
Memory: 4k page, physical 8388608k(25188k free)

/proc/meminfo:

CommandLine flags: -XX:CompressedClassSpaceSize=260046848 -XX:InitialHeapSize=536870912 -XX:MaxHeapSize=536870912 -XX:MaxMetaspaceSize=268435456 -XX:MetaspaceSize=134217728 -XX:+PrintGC -XX:+PrintGCTimeStamps -XX:+UseCompressedClassPointers -XX:+UseCompressedOops -XX:+UseG1GC
2.200: [GC pause (G1 Evacuation Pause) (young) 29M->8045K(512M), 0.0089627 secs]
3.407: [GC pause (G1 Evacuation Pause) (young) 31M->16M(512M), 0.0109194 secs]
4.773: [GC pause (G1 Evacuation Pause) (young) 46M->24M(512M), 0.0054238 secs]
6.996: [GC pause (G1 Evacuation Pause) (young) 73M->40M(512M), 0.0090299 secs]
9.498: [GC pause (G1 Evacuation Pause) (young) 93M->60M(512M), 0.0107493 secs]
13.065: [GC pause (G1 Evacuation Pause) (young) 136M->84M(512M), 0.0306780 secs]
17.593: [GC pause (G1 Evacuation Pause) (young) 183M->112M(512M), 0.0472426 secs]
22.107: [GC pause (G1 Evacuation Pause) (young) 217M->149M(512M), 0.0372447 secs]
29.760: [GC pause (G1 Humongous Allocation) (young) (initial-mark) 334M->203M(512M), 0.0278823 secs]
29.789: [GC concurrent-root-region-scan-start]
29.789: [GC concurrent-root-region-scan-end, 0.0003260 secs]
29.789: [GC concurrent-mark-start]
29.794: [GC concurrent-mark-end, 0.0049828 secs]
29.794: [GC remark, 0.0066546 secs]
29.801: [GC cleanup 204M->203M(512M), 0.0009035 secs]
29.802: [GC concurrent-cleanup-start]
29.802: [GC concurrent-cleanup-end, 0.0000222 secs]
36.182: [GC pause (G1 Evacuation Pause) (young) 360M->250M(512M), 0.0352044 secs]
36.511: [GC pause (G1 Evacuation Pause) (mixed) 258M->238M(512M), 0.0062658 secs]
```

2.2s至22.107s均为young gc，会stw，31M->16M(512M)表示堆内存512m，使用量从31M降低至16M。29.76s因为大对象分配失败开始并发循环的初始标记阶段，和young gc同时进行是为了利用young gc的gc roots，29.789s并发根区域扫描，扫描survivor区，因为young gc之后新生代中只有survivor区有对象，可以加快后续的并发标记，这个过程需要在下一次young gc之前完成，否则survivor区对象不一致。29.789s开始并发标记，通过SATB的方式，并发过程中通过写屏障记录了被切断的引用。29.801s进入cleanup阶段，根据region的统计信息将region按优先级排序，另外不含任何存活对象的region可以直接释放掉，相关的RSet也会被清理，29.802s进入并发cleanup阶段，将空闲region加入空闲列表。36.511s是mix gc，回收新生代及部分老年代，G1通过动态调整young区大小以及清理部分优先级较高的old区达到gc停顿可控。在并发循环之后可以有多个mix gc。