

1. 使用 GCLogAnalysis.java 自己演练一遍串行 / 并行 / CMS/G1 的案例。

2. 使用压测工具 (wrk 或 sb) , 演练 gateway-server-0.0.1-SNAPSHOT.jar 示例。

3. 根据上述自己对于 1 和 2 的演示, 写一段对于不同 GC 的总结。

解答:

1、使用 GCLogAnalysis.java 演练串行 / 并行 / CMS/G1 :

串行GC:

```
java -XX:+UseSerialGC -Xms1g -Xmx1g -Xloggc:gc.demo.log -XX:+PrintGCDetails -  
XX:+PrintGCDates GCLogAnalysis
```

```
~/Sites/javaspace/homework/demo/week02/src > java -XX:+UseSerialGC -Xms1g -Xmx1g -Xloggc:gc.serial.log -XX:+PrintGCDetails -XX:+PrintGCDates GCLogAnalysis  
正在执行...  
执行结束!共生成对象次数:14268
```

共生成对象: 14268

```
CommandLine flags: -XX:InitialHeapSize=1073741824 -XX:MaxHeapSize=1073741824 -XX:+PrintGC -XX:+PrintGCDates -XX:+PrintGCDetails -XX:+PrintGCTimeStamps  
-XX:+UseCompressedClassPointers -XX:+UseCompressedOops -XX:+UseSerialGC  
2020-10-26T13:41:13.616-0800: 0.224: [GC (Allocation Failure) 2020-10-26T13:41:13.616-0800: 0.224: [DefNew: 279616K->34944K(314560K), 0.0416419 secs]  
279616K->80252K(1013632K), 0.0417670 secs] [Times: user=0.03 sys=0.01, real=0.04 secs]  
2020-10-26T13:41:13.689-0800: 0.297: [GC (Allocation Failure) 2020-10-26T13:41:13.689-0800: 0.297: [DefNew: 314560K->34944K(314560K), 0.0586346 secs]  
359868K->159144K(1013632K), 0.0587394 secs] [Times: user=0.03 sys=0.02, real=0.04 secs]  
2020-10-26T13:41:13.780-0800: 0.388: [GC (Allocation Failure) 2020-10-26T13:41:13.780-0800: 0.388: [DefNew: 314560K->34943K(314560K), 0.0421379 secs]  
438760K->322321K(1013632K), 0.0422097 secs] [Times: user=0.02 sys=0.02, real=0.04 secs]  
2020-10-26T13:41:13.850-0800: 0.458: [GC (Allocation Failure) 2020-10-26T13:41:13.850-0800: 0.458: [DefNew: 314559K->34940K(314560K), 0.0460266 secs]  
511847K->314172K(1013632K), 0.0460976 secs] [Times: user=0.02 sys=0.02, real=0.04 secs]  
2020-10-26T13:41:13.925-0800: 0.532: [GC (Allocation Failure) 2020-10-26T13:41:13.925-0800: 0.532: [DefNew: 314556K->34943K(314560K), 0.0433639 secs]  
593788K->992671K(1013632K), 0.0434423 secs] [Times: user=0.03 sys=0.02, real=0.04 secs]  
2020-10-26T13:41:13.996-0800: 0.604: [GC (Allocation Failure) 2020-10-26T13:41:13.996-0800: 0.604: [DefNew: 314559K->34943K(314560K), 0.0437076 secs]  
672287K->471340K(1013632K), 0.0437802 secs] [Times: user=0.02 sys=0.02, real=0.05 secs]  
2020-10-26T13:41:14.067-0800: 0.674: [GC (Allocation Failure) 2020-10-26T13:41:14.067-0800: 0.674: [DefNew: 314559K->34943K(314560K), 0.0467492 secs]  
750956K->559573K(1013632K), 0.0468232 secs] [Times: user=0.03 sys=0.02, real=0.05 secs]  
2020-10-26T13:41:14.139-0800: 0.747: [GC (Allocation Failure) 2020-10-26T13:41:14.139-0800: 0.747: [DefNew: 314559K->34943K(314560K), 0.0377677 secs]  
839189K->632031K(1013632K), 0.0378754 secs] [Times: user=0.02 sys=0.01, real=0.04 secs]  
2020-10-26T13:41:14.206-0800: 0.813: [GC (Allocation Failure) 2020-10-26T13:41:14.206-0800: 0.813: [DefNew: 314559K->34943K(314560K), 0.0456683 secs]  
911647K->714319K(1013632K), 0.0457445 secs] [Times: user=0.03 sys=0.02, real=0.05 secs]  
2020-10-26T13:41:14.280-0800: 0.887: [GC (Allocation Failure) 2020-10-26T13:41:14.280-0800: 0.887: [DefNew: 314385K->314385K(314560K), 0.0000156  
secs] [Times: user=0.05 sys=0.00, real=0.05 secs]  
2020-10-26T13:41:14.366-0800: 0.973: [GC (Allocation Failure) 2020-10-26T13:41:14.366-0800: 0.973: [DefNew: 279616K->34943K(314560K), 0.0096953 secs]  
656058K->465448K(1013632K), 0.0097543 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]  
2020-10-26T13:41:14.402-0800: 1.009: [GC (Allocation Failure) 2020-10-26T13:41:14.402-0800: 1.009: [DefNew: 314559K->34943K(314560K), 0.0117888 secs]  
745064K->545824K(1013632K), 0.0118664 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]  
2020-10-26T13:41:14.442-0800: 1.049: [GC (Allocation Failure) 2020-10-26T13:41:14.442-0800: 1.049: [DefNew: 314559K->34944K(314560K), 0.0114729 secs]  
825440K->625228K(1013632K), 0.0115567 secs] [Times: user=0.01 sys=0.00, real=0.01 secs]  
Heap  
def new generation total 314560K, used 221901K [0x0000000780000000, 0x0000000795550000, 0x0000000795550000)  
eden space 279616K, 66% used [0x0000000780000000, 0x000000078b6936db, 0x0000000791110000)  
from space 34944K, 10% used [0x0000000791110000, 0x0000000793330000, 0x0000000793330000)  
to space 34944K, 0% used [0x0000000793330000, 0x0000000793330000, 0x0000000795550000)
```

并行GC:

```
java -XX:+UseParallelGC -Xms1g -Xmx1g -Xloggc:gc.demo.log -XX:+PrintGCDetails -  
XX:+PrintGCDates GCLogAnalysis
```

```
x ~/Sites/javaspace/homework/demo/week02/src > java -XX:+UseParallelGC -Xms1g -Xmx1g -Xloggc:gc.parallel.log -XX:+PrintGCDetails -XX:+PrintGCDates GCLogAnalysis  
正在执行...  
执行结束!共生成对象次数:16578
```

共生成对象: 16578

```

CommandLine flags: -XX:InitialHeapSize=1073741824 -XX:MaxHeapSize=1073741824 -XX:+PrintGC -XX:+PrintGCDetails -XX:+PrintGCTimeStamps
-XX:+UseCompressedClassPointers -XX:+UseCompressedOops -XX:+UseParallelGC
2020-10-26T13:44:01.246-0800: 0.21b: [GC (Allocation Failure) [PSYoungGen: 262144K->43517K(305664K)] 262144K->82019K(1005056K), 0.0310864 secs] Times: user=0.03 sys=0.15,
real=0.03 secs]
2020-10-26T13:44:01.309-0800: 0.281: [GC (Allocation Failure) [PSYoungGen: 305024K->43514K(305664K)] 343525K->151043K(1005056K), 0.0437023 secs] Times: user=0.05
sys=0.21, real=0.05 secs]
2020-10-26T13:44:01.383-0800: 0.355: [GC (Allocation Failure) [PSYoungGen: 305241K->43507K(305664K)] 412770K->225232K(1005056K), 0.0283692 secs] Times: user=0.05
sys=0.12, real=0.03 secs]
2020-10-26T13:44:01.438-0800: 0.410: [GC (Allocation Failure) [PSYoungGen: 305628K->43510K(305664K)] 487353K->296303K(1005056K), 0.0260484 secs] Times: user=0.05
sys=0.12, real=0.03 secs]
2020-10-26T13:44:01.491-0800: 0.463: [GC (Allocation Failure) [PSYoungGen: 305654K->43507K(305664K)] 558447K->366722K(1005056K), 0.0292034 secs] Times: user=0.04
sys=0.13, real=0.03 secs]
2020-10-26T13:44:01.546-0800: 0.518: [GC (Allocation Failure) [PSYoungGen: 305651K->43508K(160256K)] 628866K->442933K(859648K), 0.0312489 secs] Times: user=0.04 sys=0.14,
real=0.03 secs]
2020-10-26T13:44:01.589-0800: 0.561: [GC (Allocation Failure) [PSYoungGen: 160244K->74607K(232960K)] 559669K->483917K(932352K), 0.0060452 secs] Times: user=0.02 sys=0.02,
real=0.01 secs]
2020-10-26T13:44:01.607-0800: 0.579: [GC (Allocation Failure) [PSYoungGen: 191343K->99971K(232960K)] 600653K->519330K(932352K), 0.0084722 secs] Times: user=0.04
real=0.01 secs]
2020-10-26T13:44:01.627-0800: 0.599: [GC (Allocation Failure) [PSYoungGen: 216707K->116144K(232960K)] 636066K->549765K(932352K), 0.0109106 secs] Times: user=0.04
sys=0.03, real=0.01 secs]
2020-10-26T13:44:01.658-0800: 0.621: [GC (Allocation Failure) [PSYoungGen: 232880K->73811K(232960K)] 666501K->574007K(932352K), 0.0243552 secs] Times: user=0.04 sys=0.11,
real=0.02 secs]
2020-10-26T13:44:01.685-0800: 0.657: [GC (Allocation Failure) [PSYoungGen: 190382K->44509K(232960K)] 690668K->612040K(932352K), 0.0244184 secs] Times: user=0.04 sys=0.10,
real=0.03 secs]
2020-10-26T13:44:01.721-0800: 0.693: [GC (Allocation Failure) [PSYoungGen: 161245K->38145K(232960K)] 728776K->645497K(932352K), 0.0185882 secs] Times: user=0.03 sys=0.05,
real=0.02 secs]
2020-10-26T13:44:01.749-0800: 0.712: [Full GC (Ergonomics) [PSYoungGen: 38145K->0K(232960K)] [ParOldGen: 607351K->332631K(699392K)] 645497K->332631K(932352K), [Metaspace:
2706K->2706K(1056768K)], 0.0303396 secs] Times: user=0.16 sys=0.01, real=0.03 secs]
2020-10-26T13:44:01.765-0800: 0.756: [GC (Allocation Failure) [PSYoungGen: 161245K->38145K(232960K)] 728776K->645497K(932352K), [Metaspace:
2706K->2706K(1056768K)], 0.0303396 secs] Times: user=0.16 sys=0.01, real=0.03 secs]

```

CMS:

```

java -XX:+UseConcMarkSweepGC -Xms1g -Xmx1g -Xloggc:gc.demo.log -XX:+PrintGCDetails
-XX:+PrintGCDates Stamps GCLogAnalysis

```

```

~/Sites/javaspace/homework/demo/week02/src> java -XX:+UseConcMarkSweepGC -Xms1g -Xmx1g -Xloggc:gc.cms.log -XX:+PrintGCDetails -XX:+PrintGCDates Stamps GCLogAnalysis
正在执行...
执行结束!共生成对象次数:15764

```

生成对象: 15764

```

CommandLine flags: -XX:InitialHeapSize=1073741824 -XX:MaxHeapSize=1073741824 -XX:MaxNewSize=357916672 -XX:MaxTenuringThreshold=6 -XX:NewSize=357916672 -XX:OldPLABSize=16
-XX:OldSize=715825152 -XX:+PrintGC -XX:+PrintGCDates Stamps -XX:+PrintGCDetails -XX:+PrintGCTimeStamps -XX:+UseCompressedClassPointers -XX:+UseCompressedOops
-XX:+UseConcMarkSweepGC -XX:+UseParNewGC
2020-10-26T13:47:23.809-0800: 0.233: [GC (Allocation Failure) 2020-10-26T13:47:23.809-0800: 0.234: [ParNew: 279616K->34943K(314560K), 0.0310470 secs] Times: user=0.06 sys=0.15,
real=0.04 secs]
279616K->84497K(1013632K), 0.0311611 secs] Times: user=0.06 sys=0.15, real=0.04 secs]
2020-10-26T13:47:23.873-0800: 0.297: [GC (Allocation Failure) 2020-10-26T13:47:23.873-0800: 0.297: [ParNew: 314559K->34943K(314560K), 0.0348555 secs] Times: user=0.07 sys=0.15,
real=0.03 secs]
364113K->162099K(1013632K), 0.0349304 secs] Times: user=0.07 sys=0.15, real=0.03 secs]
2020-10-26T13:47:23.935-0800: 0.360: [GC (Allocation Failure) 2020-10-26T13:47:23.935-0800: 0.360: [ParNew: 314559K->34944K(314560K), 0.0469839 secs] Times: user=0.32 sys=0.03,
real=0.05 secs]
441708K->241974K(1013632K), 0.0470551 secs] Times: user=0.32 sys=0.03, real=0.05 secs]
2020-10-26T13:47:24.012-0800: 0.436: [GC (Allocation Failure) 2020-10-26T13:47:24.012-0800: 0.436: [ParNew: 314560K->34943K(314560K), 0.0430410 secs] Times: user=0.32 sys=0.02,
real=0.04 secs]
521590K->315513K(1013632K), 0.0431549 secs] Times: user=0.32 sys=0.02, real=0.04 secs]
2020-10-26T13:47:24.080-0800: 0.505: [GC (Allocation Failure) 2020-10-26T13:47:24.080-0800: 0.505: [ParNew: 314559K->34944K(314560K), 0.0418132 secs] Times: user=0.32 sys=0.02,
real=0.04 secs]
595129K->399880K(1013632K), 0.0419923 secs] Times: user=0.31 sys=0.03, real=0.04 secs]
2020-10-26T13:47:24.122-0800: 0.547: [GC (CMS Initial Mark) [1 CMS-initial-mark: 355936K(699072K)] 397748K(1013632K), 0.0002896 secs] Times: user=0.00 sys=0.00, real=0.00
secs]
2020-10-26T13:47:24.123-0800: 0.547: [CMS-concurrent-mark-start]
2020-10-26T13:47:24.126-0800: 0.550: [CMS-concurrent-mark: 0.003/0.003 secs] Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-26T13:47:24.126-0800: 0.550: [CMS-concurrent-preclean-start]
2020-10-26T13:47:24.127-0800: 0.551: [CMS-concurrent-preclean: 0.001/0.001 secs] Times: user=0.01 sys=0.00, real=0.00 secs]
2020-10-26T13:47:24.127-0800: 0.551: [CMS-concurrent-abortable-preclean-start]
2020-10-26T13:47:24.148-0800: 0.572: [GC (Allocation Failure) 2020-10-26T13:47:24.148-0800: 0.572: [ParNew: 314560K->34943K(314560K), 0.0448959 secs] Times: user=0.33 sys=0.02,
real=0.05 secs]
670496K->471745K(1013632K), 0.0449678 secs] Times: user=0.33 sys=0.02, real=0.05 secs]
2020-10-26T13:47:24.221-0800: 0.645: [GC (Allocation Failure) 2020-10-26T13:47:24.221-0800: 0.645: [ParNew: 314559K->34942K(314560K), 0.0436310 secs] Times: user=0.31 sys=0.03,
real=0.04 secs]
751361K->547006K(1013632K), 0.0437035 secs] Times: user=0.31 sys=0.03, real=0.04 secs]
2020-10-26T13:47:24.293-0800: 0.717: [GC (Allocation Failure) 2020-10-26T13:47:24.293-0800: 0.717: [ParNew: 314558K->34943K(314560K), 0.0437641 secs] Times: user=0.32 sys=0.03,
real=0.04 secs]
826622K->625322K(1013632K), 0.0438376 secs] Times: user=0.32 sys=0.03, real=0.04 secs]
2020-10-26T13:47:24.363-0800: 0.787: [GC (Allocation Failure) 2020-10-26T13:47:24.363-0800: 0.787: [ParNew: 314559K->34942K(314560K), 0.0471264 secs] Times: user=0.33 sys=0.02,
real=0.05 secs]
904938K->709855K(1013632K), 0.0472346 secs] Times: user=0.33 sys=0.02, real=0.05 secs]
2020-10-26T13:47:24.410-0800: 0.834: [GC (Concurrent-Abortable-Preclean) 0.008/0.283 secs] Times: user=1.39 sys=0.10, real=0.29 secs]
2020-10-26T13:47:24.410-0800: 0.835: [GC (CMS Final Remark) [YG occupancy: 35111 K (314560 K)] 2020-10-26T13:47:24.410-0800: 0.835: [Rescan (parallel) , 0.0004559
secs] 2020-10-26T13:47:24.411-0800: 0.835: [Waste rets processing, 0.0000214 secs] 2020-10-26T13:47:24.411-0800: 0.835: [class unloading, 0.0002477
secs] 2020-10-26T13:47:24.411-0800: 0.835: [scrub symbol table, 0.0002306 secs] 2020-10-26T13:47:24.411-0800: 0.836: [scrub string table, 0.0001562 secs]] [1 CMS-remark:
674914K(699072K) 710026K(1013632K), 0.0011947 secs] Times: user=0.01 sys=0.00, real=0.00 secs]
2020-10-26T13:47:24.411-0800: 0.836: [CMS-concurrent-sweep-start]
2020-10-26T13:47:24.411-0800: 0.837: [CMS-concurrent-sweep: 0.001/0.001 secs] Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-26T13:47:24.413-0800: 0.837: [CMS-concurrent-reset-start]
2020-10-26T13:47:24.413-0800: 0.837: [CMS-concurrent-reset: 0.002/0.002 secs] Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-26T13:47:24.439-0800: 0.863: [GC (Allocation Failure) 2020-10-26T13:47:24.439-0800: 0.863: [ParNew: 314558K->34943K(314560K), 0.0135830 secs] Times: user=0.10 sys=0.01,
real=0.02 secs]
861796K->659236K(1013632K), 0.0136610 secs] Times: user=0.10 sys=0.01, real=0.02 secs]
2020-10-26T13:47:24.453-0800: 0.877: [GC (CMS Initial Mark) [1 CMS-initial-mark: 62492K(699072K)] 665652K(1013632K), 0.0002052 secs] Times: user=0.00 sys=0.00, real=0.00
secs]
2020-10-26T13:47:24.453-0800: 0.877: [CMS-concurrent-mark-start]
2020-10-26T13:47:24.455-0800: 0.879: [CMS-concurrent-mark: 0.002/0.002 secs] Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-26T13:47:24.455-0800: 0.879: [CMS-concurrent-preclean-start]
2020-10-26T13:47:24.456-0800: 0.880: [CMS-concurrent-preclean: 0.001/0.001 secs] Times: user=0.01 sys=0.00, real=0.00 secs]

```

G1:

```

java -XX:+UseG1GC -Xms1g -Xmx1g -Xloggc:gc.g1.log -XX:+PrintGC -
XX:+PrintGCDates Stamps GCLogAnalysis

```

```

~/Sites/javaspace/homework/demo/week02/src> java -XX:+UseG1GC -Xms1g -Xmx1g -Xloggc:gc.g1.log -XX:+PrintGC -XX:+PrintGCDates Stamps GCLogAnalysis
正在执行...
执行结束!共生成对象次数:16071

```

生成对象: 16071

```

CommandLine flags: -XX:InitialHeapSize=1073741824 -XX:MaxHeapSize=1073741824 -XX:+PrintGC -XX:+PrintGCDates -XX:+PrintGCTimeStamps -XX:+UseCompressedClassPointers
-XX:+UseCompressedOops -XX:+UseG1GC
2020-10-26T13:54:34.369-0800: 0.130: [GC pause (G1 Evacuation Pause) (young) 61M->20M(1024M), 0.0050337 secs]
2020-10-26T13:54:34.385-0800: 0.146: [GC pause (G1 Evacuation Pause) (young) 74M->38M(1024M), 0.0050012 secs]
2020-10-26T13:54:34.402-0800: 0.162: [GC pause (G1 Evacuation Pause) (young) 95M->59M(1024M), 0.0057898 secs]
2020-10-26T13:54:34.428-0800: 0.189: [GC pause (G1 Evacuation Pause) (young) 141M->84M(1024M), 0.0070841 secs]
2020-10-26T13:54:34.507-0800: 0.357: [GC pause (G1 Evacuation Pause) (young) 472M->202M(1024M), 0.0292747 secs]
2020-10-26T13:54:34.635-0800: 0.395: [GC pause (G1 Evacuation Pause) (young) 264M->216M(1024M), 0.0047910 secs]
2020-10-26T13:54:34.663-0800: 0.423: [GC pause (G1 Evacuation Pause) (young) 378M->263M(1024M), 0.0101864 secs]
2020-10-26T13:54:34.704-0800: 0.464: [GC pause (G1 Evacuation Pause) (young) 464M->317M(1024M), 0.0151562 secs]
2020-10-26T13:54:34.768-0800: 0.529: [GC pause (G1 Evacuation Pause) (young) 615M->391M(1024M), 0.0168471 secs]
2020-10-26T13:54:34.808-0800: 0.568: [GC pause (G1 Humongous Allocation) (young) (initial-mark) 561M->423M(1024M), 0.0055385 secs]
2020-10-26T13:54:34.813-0800: 0.574: [GC concurrent-root-region-scan-start]
2020-10-26T13:54:34.814-0800: 0.574: [GC concurrent-root-region-scan-end, 0.0000835 secs]
2020-10-26T13:54:34.816-0800: 0.576: [GC concurrent-mark-start]
2020-10-26T13:54:34.816-0800: 0.576: [GC concurrent-mark-end, 0.0023337 secs]
2020-10-26T13:54:34.816-0800: 0.576: [GC remark, 0.0012169 secs]
2020-10-26T13:54:34.817-0800: 0.578: [GC cleanup 441M->429M(1024M), 0.0006687 secs]
2020-10-26T13:54:34.818-0800: 0.578: [GC concurrent-cleanup-start]
2020-10-26T13:54:34.818-0800: 0.578: [GC concurrent-cleanup-end, 0.0000116 secs]
2020-10-26T13:54:34.879-0800: 0.640: [GC pause (G1 Evacuation Pause) (young) 794M->493M(1024M), 0.0306712 secs]
2020-10-26T13:54:34.912-0800: 0.672: [GC pause (G1 Evacuation Pause) (mixed) 505M->410M(1024M), 0.0061084 secs]
2020-10-26T13:54:34.925-0800: 0.685: [GC pause (G1 Evacuation Pause) (mixed) 468M->418M(1024M), 0.0017051 secs]
2020-10-26T13:54:34.927-0800: 0.687: [GC pause (G1 humongous Allocation) (young) (initial-mark) 419M->417M(1024M), 0.0009936 secs]
2020-10-26T13:54:34.928-0800: 0.688: [GC concurrent-root-region-scan-start]
2020-10-26T13:54:34.928-0800: 0.688: [GC concurrent-root-region-scan-end, 0.0000661 secs]
2020-10-26T13:54:34.928-0800: 0.688: [GC concurrent-mark-start]
2020-10-26T13:54:34.929-0800: 0.689: [GC concurrent-mark-end, 0.0000809 secs]
2020-10-26T13:54:34.929-0800: 0.689: [GC remark, 0.0009354 secs]
2020-10-26T13:54:34.930-0800: 0.690: [GC cleanup 425M->419M(1024M), 0.0005445 secs]
2020-10-26T13:54:34.930-0800: 0.691: [GC concurrent-cleanup-start]
2020-10-26T13:54:34.930-0800: 0.691: [GC concurrent-cleanup-end, 0.0000105 secs]
2020-10-26T13:54:34.983-0800: 0.743: [GC pause (G1 Evacuation Pause) (young) 840M->590M(1024M), 0.0083746 secs]
2020-10-26T13:54:34.993-0800: 0.753: [GC pause (G1 Evacuation Pause) (mixed) 599M->533M(1024M), 0.0060801 secs]
2020-10-26T13:54:34.999-0800: 0.759: [GC pause (G1 Humongous Allocation) (young) (initial-mark) 534M->533M(1024M), 0.0021835 secs]
2020-10-26T13:54:35.001-0800: 0.760: [GC concurrent-root-region-scan-start]
2020-10-26T13:54:35.001-0800: 0.762: [GC concurrent-root-region-scan-end, 0.0000791 secs]
2020-10-26T13:54:35.001-0800: 0.762: [GC concurrent-mark-start]
2020-10-26T13:54:35.003-0800: 0.763: [GC concurrent-mark-end, 0.0012022 secs]
2020-10-26T13:54:35.003-0800: 0.763: [GC remark, 0.0019051 secs]
2020-10-26T13:54:35.005-0800: 0.765: [GC cleanup 544M->542M(1024M), 0.0007454 secs]
2020-10-26T13:54:35.005-0800: 0.766: [GC concurrent-cleanup-start]
2020-10-26T13:54:35.006-0800: 0.766: [GC concurrent-cleanup-end, 0.0000110 secs]
2020-10-26T13:54:35.042-0800: 0.803: [GC pause (G1 Evacuation Pause) (young) 848M->595M(1024M), 0.0053865 secs]

```

```

2020-10-26T14:00:28.387-0800: 0.543: [GC pause (G1 Humongous Allocation) (young) (initial-mark), 0.0089629 secs]
[Parallel Time: 8.3 ms, GC Workers: 8]
[GC Worker Start (ms): Min: 543.3, Avg: 543.4, Max: 543.5, Diff: 0.2]
[Ext Root Scanning (ms): Min: 0.1, Avg: 0.1, Max: 0.2, Diff: 0.2, Sum: 0.9]
[Update RS (ms): Min: 0.2, Avg: 0.2, Max: 0.3, Diff: 0.2, Sum: 1.7]
[Processed Buffers: Min: 0, Avg: 2.2, Max: 3, Diff: 3, Sum: 18]
[Scan RS (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.1]
[Code Root Scanning (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.0]
[Object Copy (ms): Min: 7.3, Avg: 7.4, Max: 7.6, Diff: 0.3, Sum: 59.6]
[Termination (ms): Min: 0.0, Avg: 0.2, Max: 0.4, Diff: 0.4, Sum: 1.5]
[Termination Attempts: Min: 1, Avg: 1.0, Max: 1, Diff: 0, Sum: 8]
[GC Worker Other (ms): Min: 0.0, Avg: 0.0, Max: 0.0, Diff: 0.0, Sum: 0.1]
[GC Worker Total (ms): Min: 7.9, Avg: 8.0, Max: 8.2, Diff: 0.3, Sum: 63.9]
[GC Worker End (ms): Min: 551.3, Avg: 551.4, Max: 551.5, Diff: 0.2]
[Code Root Fixup: 0.0 ms]
[Code Root Purge: 0.0 ms]
[Clear CT: 0.1 ms]
[Other: 0.6 ms]
[Choose CSet: 0.0 ms]
[Ref Proc: 0.2 ms]
[Ref Enq: 0.0 ms]
[Redirty Cards: 0.1 ms]
[Humongous Register: 0.1 ms]
[Humongous Reclaim: 0.1 ms]
[Free CSet: 0.0 ms]
[Eden: 146.0M(283.0M)->0.0B(345.0M) Survivors: 32.0M->40.0M Heap: 568.1M(1024.0M)->422.4M(1024.0M)]
[Times: user=0.03 sys=0.03, real=0.01 secs]
2020-10-26T14:00:28.396-0800: 0.552: [GC concurrent-root-region-scan-start]
2020-10-26T14:00:28.396-0800: 0.552: [GC concurrent-root-region-scan-end, 0.0000933 secs]
2020-10-26T14:00:28.396-0800: 0.552: [GC concurrent-mark-start]
2020-10-26T14:00:28.398-0800: 0.555: [GC concurrent-mark-end, 0.0022984 secs]
2020-10-26T14:00:28.398-0800: 0.555: [GC remark 2020-10-26T14:00:28.398-0800: 0.555: [Finalize Marking, 0.0002521 secs] 2020-10-26T14:00:28.399-0800: 0.555: [GC ref-proc, 0.0000382 secs] 2020-10-26T14:00:28.399-0800: 0.555: [Unloading, 0.0003789 secs], 0.0011679 secs]
[Times: user=0.01 sys=0.00, real=0.00 secs]
2020-10-26T14:00:28.399-0800: 0.556: [GC cleanup 441M->430M(1024M), 0.0005782 secs]
[Times: user=0.00 sys=0.01, real=0.01 secs]
2020-10-26T14:00:28.400-0800: 0.557: [GC concurrent-cleanup-start]
2020-10-26T14:00:28.400-0800: 0.557: [GC concurrent-cleanup-end, 0.0000122 secs]
2020-10-26T14:00:28.508-0800: 0.665: [GC pause (G1 Evacuation Pause) (young) (to-space exhausted), 0.0193557 secs]
[Parallel Time: 17.6 ms, GC Workers: 8]
[GC Worker Start (ms): Min: 665.0, Avg: 665.1, Max: 665.1, Diff: 0.1]
[Ext Root Scanning (ms): Min: 0.1, Avg: 0.1, Max: 0.2, Diff: 0.1, Sum: 0.9]
[Update RS (ms): Min: 0.1, Avg: 0.2, Max: 0.5, Diff: 0.3, Sum: 1.6]
[Processed Buffers: Min: 0, Avg: 2.6, Max: 4, Diff: 4, Sum: 21]
[Scan RS (ms): Min: 0.0, Avg: 0.0, Max: 0.1, Diff: 0.0, Sum: 0.2]

```

2、压测工具演练 gateway-server-0.0.1-SNAPSHOT.jar 示例

```
wrk -t8 -c40 -d60s http://localhost:8088/api/hello
```

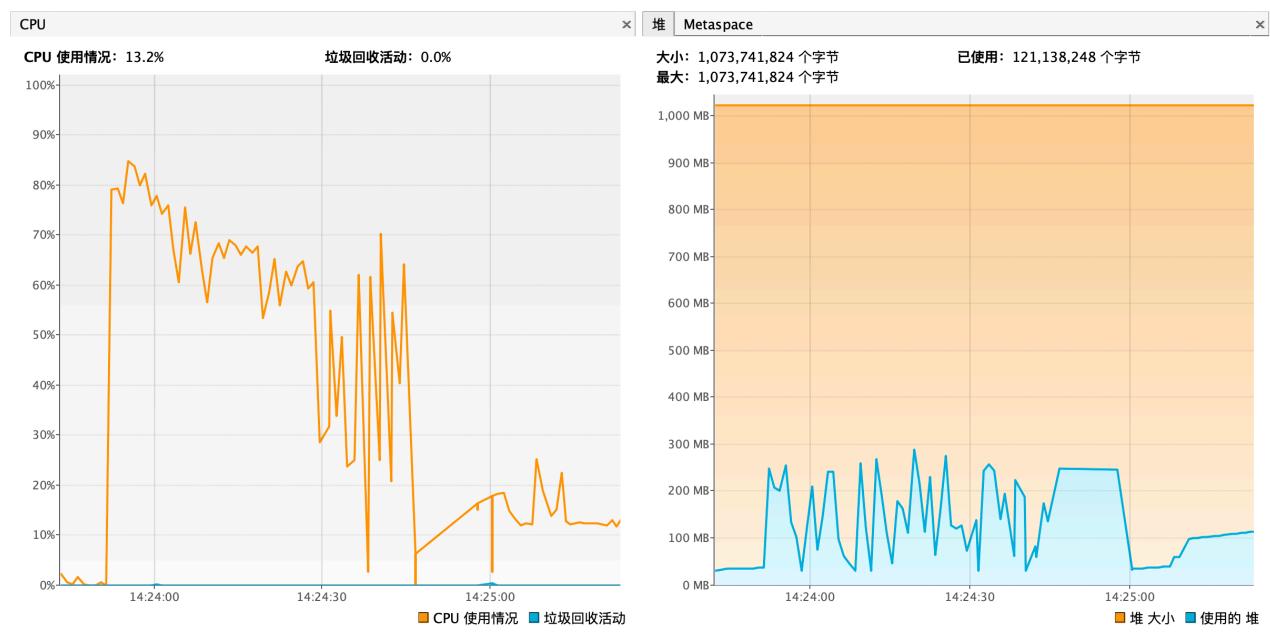
串行：

```
java -XX:+UseSerialGC -jar -Xmx1g -Xms1g gateway-server-0.0.1-SNAPSHOT.jar
```

```

~ ➤ wrk -t8 -c40 -d60s http://localhost:8088/api/hello
Running 1m test @ http://localhost:8088/api/hello
  8 threads and 40 connections
Thread Stats      Avg      Stdev      Max  +/- Stdev
  Latency    47.42ms  208.58ms   1.93s  94.78%
  Req/Sec     5.77k    2.53k   11.93k  70.48%
  2208541 requests in 1.00m, 263.68MB read
Requests/sec: 36768.18
Transfer/sec: 4.39MB

```



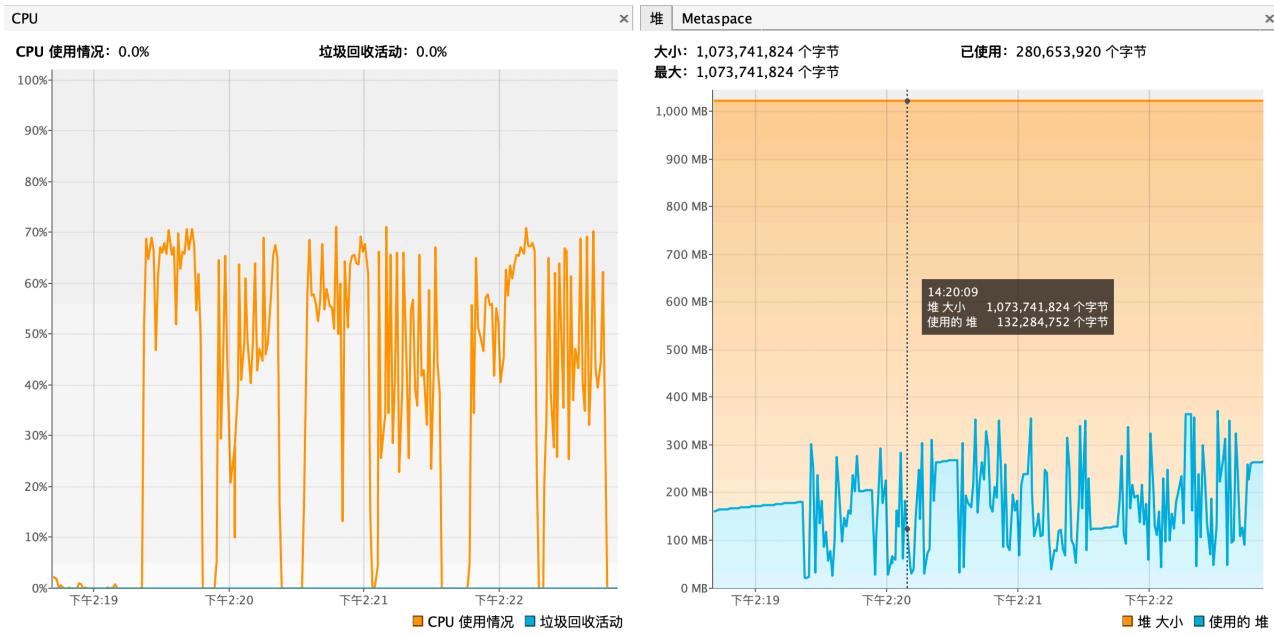
并行:

```
java -XX:+UseParallelGC -jar -Xmx1g -Xms1g gateway-server-0.0.1-SNAPSHOT.jar
```

```

~ ➤ wrk -t8 -c40 -d60s http://localhost:8088/api/hello
Running 1m test @ http://localhost:8088/api/hello
  8 threads and 40 connections
Thread Stats      Avg      Stdev      Max  +/- Stdev
  Latency    38.71ms  109.55ms  806.80ms  90.01%
  Req/Sec     7.22k    2.37k   13.41k  84.57%
  2821221 requests in 1.00m, 336.83MB read
Requests/sec: 46944.66
Transfer/sec: 5.60MB

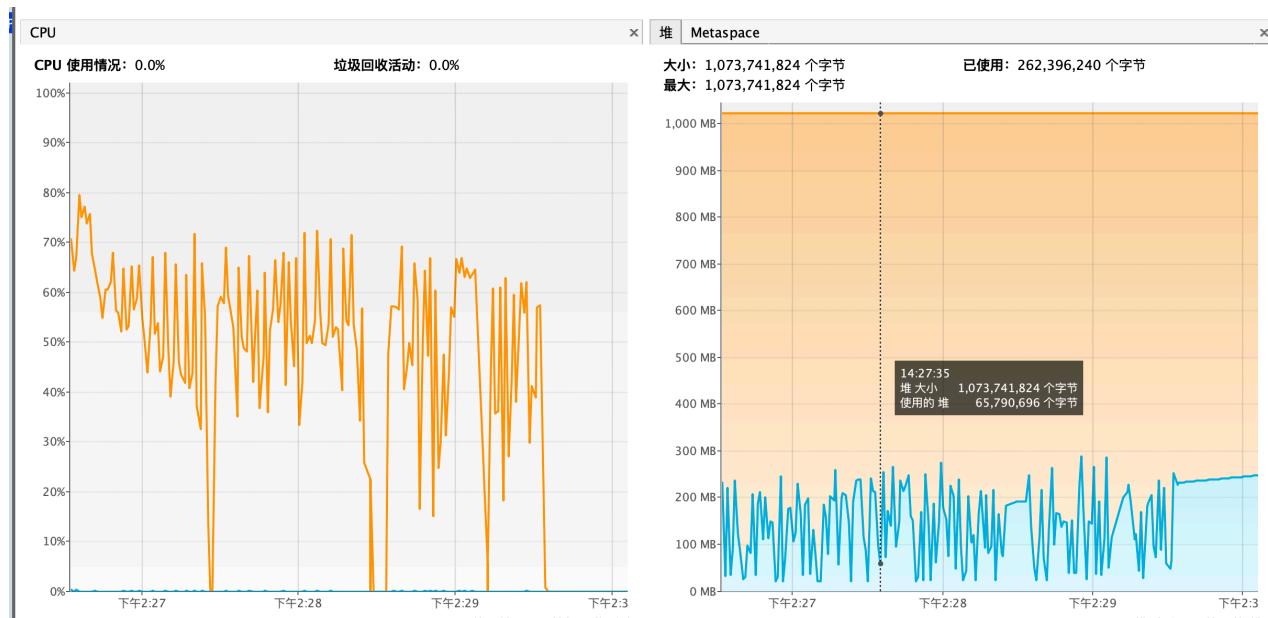
```



CMS:

```
java -XX:+UseConcMarkSweepGC -jar -Xmx1g -Xms1g gateway-server-0.0.1-SNAPSHOT.jar
```

```
x ~ wrk -t8 -c40 -d60s http://localhost:8088/api/hello
Running 1m test @ http://localhost:8088/api/hello
  8 threads and 40 connections
    Thread Stats      Avg      Stdev      Max      +/- Stdev
      Latency    17.71ms   65.04ms  627.09ms   93.53%
      Req/Sec     5.47k    2.18k   11.10k   69.72%
  2449612 requests in 1.00m, 292.46MB read
Requests/sec:  40826.83
Transfer/sec:   4.87MB
```



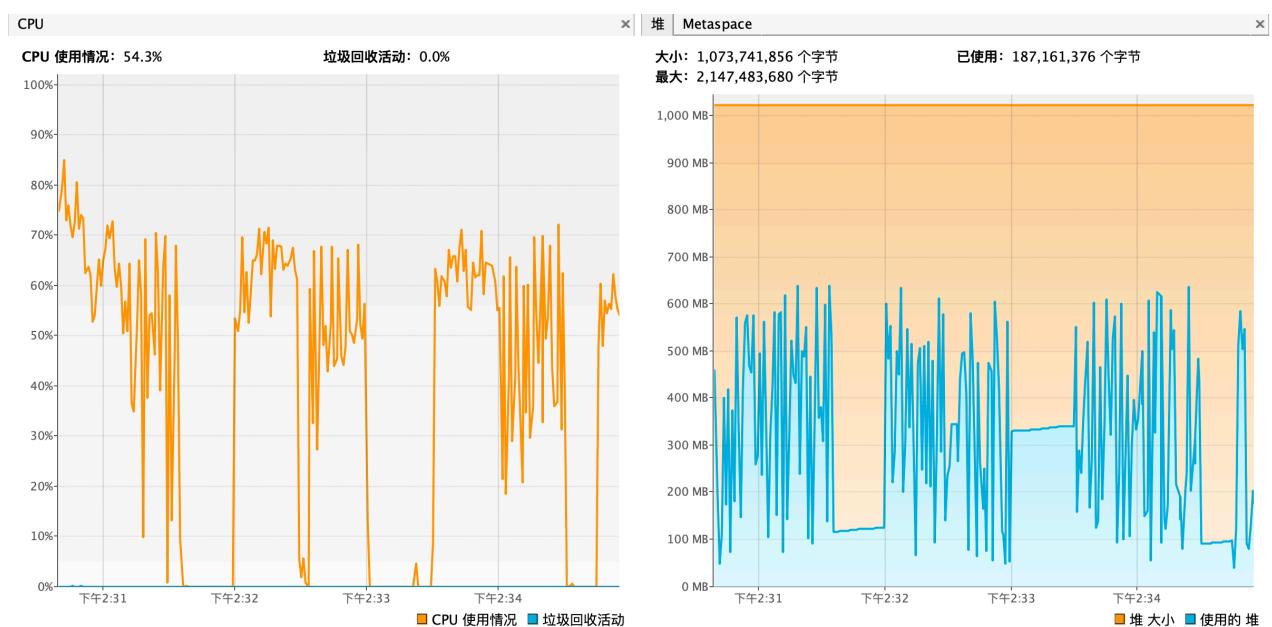
G1:

```
java -XX:+UseG1GC -jar -Xmx1g -Xms1g gateway-server-0.0.1-SNAPSHOT.jar
```

```

~ ➔ wrk -t8 -c40 -d60s http://localhost:8088/api/hello
Running 1m test @ http://localhost:8088/api/hello
  8 threads and 40 connections
Thread Stats      Avg      Stdev      Max  +/- Stdev
  Latency    17.27ms   62.91ms  602.01ms   92.86%
  Req/Sec     6.93k    1.93k   17.83k   86.12%
  2805724 requests in 1.00m, 334.98MB read
Requests/sec: 46687.53
Transfer/sec:  5.57MB

```



3、对不同GC的总结

1. 串行GC:

- 特点：单线程垃圾收集器，不能进行并行处理，年轻代和老年代都会触发STW，停止所有应用线程。
- 使用场景：只适合几百MB堆内存的JVM

2. 并行GC:

- 特点：效率高，最常调整的是线程数，`-XX:ParallelGCThreads=N`，默认是cpu核心数。处理GC的线程是多线程，与业务线程没有关系。
- 使用场景：

- 并行垃圾收集器适用于多核服务器，主要目标是增加吞吐量，因为对系统资源的有效使用，能达到更高的吞吐量。
- 在GC期间，所有CPU内核都在并行清理垃圾，所以总暂停时间更短；
- 在两次GC周期的间隔期，没有GC线程在运行，不会消耗任何系统资源。

3. CMS GC:

- 特点：避免在老年代垃圾收集时出现长时间的卡顿，最大可能的并发
- 使用场景：如果是多核CPU，主要调优目标是降低GC停顿导致的系统延迟，那么CMS是个明智的选择

4. G1 GC:

- 特点：
 - 垃圾优先，哪一块的垃圾最多就优先清理它；
 - 目标：将 STW 停顿的时间和分布，变成可预期且可配置的
 - 内存划分改变，内存切成多个小块，没有碎片
 - 停止回收：默认堆大小 5%
- 使用场景：可以做到吞吐量与效率的平衡，介于并行GC和CMS GC之间。

结合1、2例子，

串行GC共生成对象14268，GC暂停时间较长，基本在40~60ms，每秒处理请求数36768.18；

并行GC共生成对象16578，GC暂停时间更短，10~30ms，每秒处理请求数46944.66；

CMS GC共生成对象15764，GC理论上只在1和4步暂停，演示结果发现暂停时间都是0.00s，因为暂停时间太短，没有显示？每秒处理请求数40826.83；

G1 GC共生成对象16071，每秒处理请求数46687.53。

可以看出，并行GC能达到更高的吞吐量，CMS GC暂停时间更短，效率更高，G1 GC介于并行GC和CMS GC之间，符合以上结论。

问题：

```
1012424K->824335K(1013632K), [Metaspace: 2706K->2706K(1056768K)], 0.0763124 secs] [Times: user=0.07 sys=0.00, real=0.07 secs]
2020-10-26T15:28:23.897-0800: 1.088: [GC (CMS Initial Mark) [1 CMS-initial-mark: 699000K(699072K)] 825644K(1013632K), 0.0002601 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-26T15:28:23.897-0800: 1.088: [CMS-concurrent-mark-start]
2020-10-26T15:28:23.898-0800: 1.089: [CMS-concurrent-mark: 0.001/0.001 secs] [Times: user=0.01 sys=0.00, real=0.00 secs]
2020-10-26T15:28:23.898-0800: 1.089: [CMS-concurrent-preclean-start]
2020-10-26T15:28:23.900-0800: 1.091: [CMS-concurrent-preclean: 0.002/0.002 secs] [Times: user=0.00 sys=0.00, real=0.01 secs] |
2020-10-26T15:28:23.900-0800: 1.091: [CMS-concurrent-abortable-preclean-start]
2020-10-26T15:28:23.900-0800: 1.091: [CMS-concurrent-abortable-preclean: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-26T15:28:23.901-0800: 1.091: [GC (CMS Final Remark) [Y0 occupancy: 167067 K (314560 K)] 2020-10-26T15:28:23.901-0800: 1.091: [Rescan (parallel), 0.0004164 secs] 2020-10-26T15:28:23.901-0800: 1.092: [weak refs processing, 0.0000124 secs] 2020-10-26T15:28:23.901-0800: 1.092: [class unloading, 0.0001465 secs] 2020-10-26T15:28:23.901-0800: 1.092: [scrub symbol table, 0.0002312 secs] 2020-10-26T15:28:23.901-0800: 1.092: [scrub string table, 0.0001558 secs] | [1 CMS-remark: 699000K(699072K)] 866067K(1013632K), 0.0010230 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-26T15:28:23.902-0800: 1.093: [CMS-concurrent-sweep-start]
2020-10-26T15:28:23.902-0800: 1.093: [CMS-concurrent-sweep: 0.000/0.000 secs] [Times: user=0.00 sys=0.00, real=0.00 secs]
2020-10-26T15:28:23.902-0800: 1.093: [CMS-concurrent-reset-start]
Heap
par new generation total 314560K, used 172660K [0x0000000780000000, 0x0000000795550000, 0x0000000795550000)
eden space 279616K, 61% used [0x0000000780000000, 0x000000078a89d1f0, 0x0000000791110000)
from space 34944K, 0% used [0x0000000793330000, 0x0000000793330000, 0x0000000795550000)
to space 34944K, 0% used [0x0000000791110000, 0x0000000791110000, 0x0000000793330000)
concurrent mark-sweep generation total 699072K, used 699000K [0x0000000795550000, 0x00000007c0000000, 0x00000007c0000000)
```

为什么在并发预清理阶段会有0.01s的暂停？