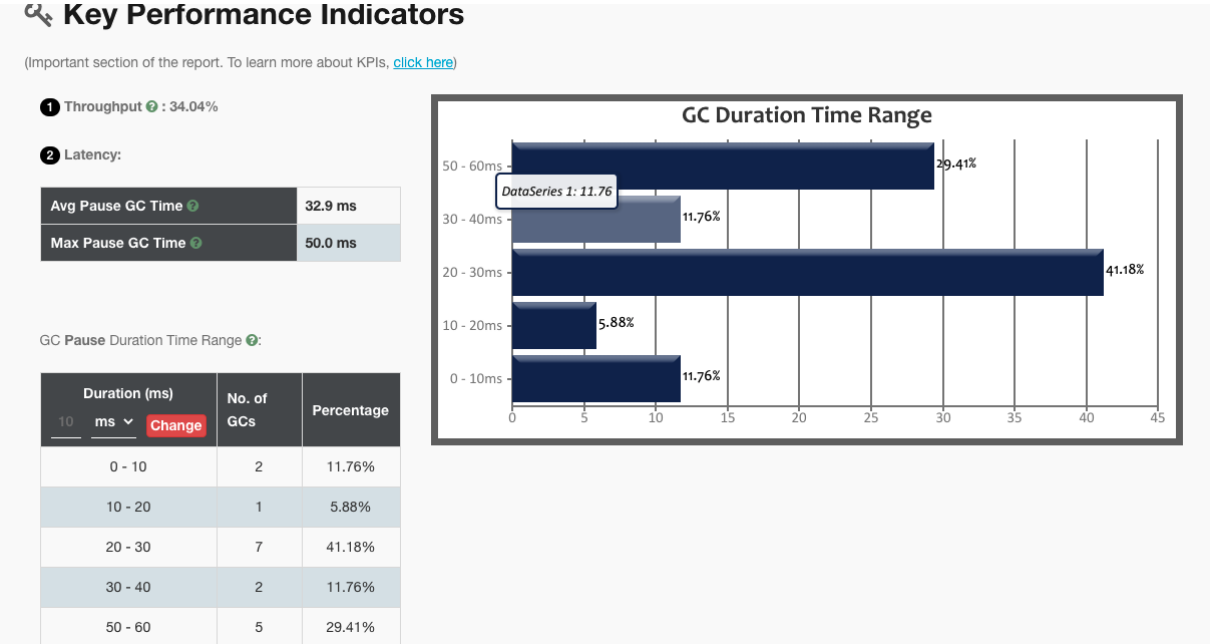
GCLogAnalysis 分析

1. 垃圾收集器

   分别使用 Serial GC、Parallel GC、CMS GC、G1GC 对 GCLogAnalysis.java 运行分析，使用参数分别为-Xmx512m -Xms512m，-Xmx1g -Xms1g，-Xmx2g -Xms2g，-Xmx4g -Xms4g 以及不设置-Xms。输出文档:GC_LOG，使用 GC Easy 对结果进行图形化展示。

2. 串行 GC 分析

   1）GC 暂停时间



   -Xmx512m -Xms512m 时，GC 暂停时间最优，平均 GC 暂停时间为 32.9ms，最长 GC 暂停时间为 50ms。20-30 时间段内占比相对较高。

(Important section of the report. To learn more about KPIs, click here)

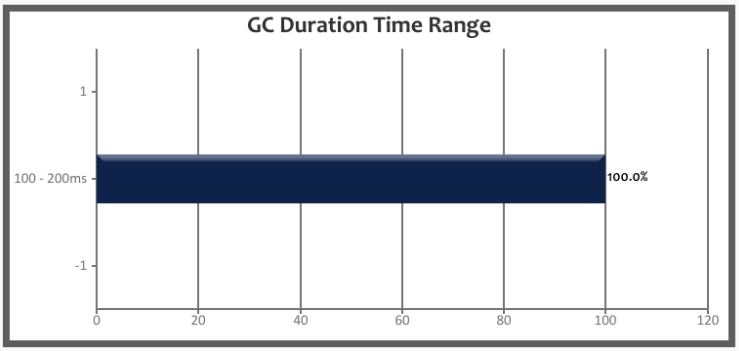
1 Throughput : 7.692%

2 Latency:

Avg Pause GC Time	150 ms
Max Pause GC Time	170 ms

GC Pause Duration Time Range:

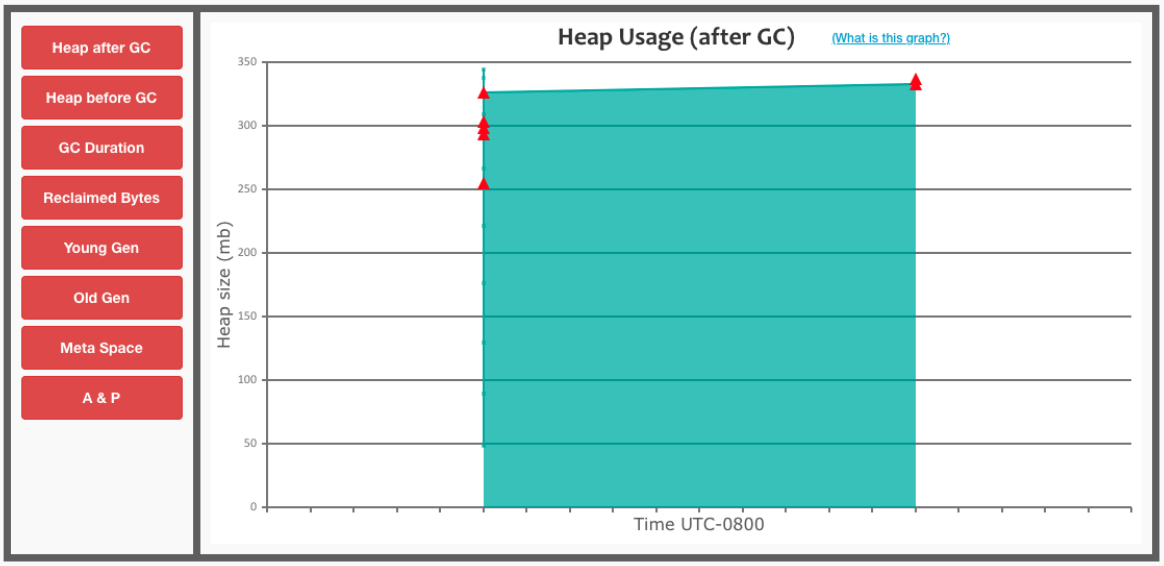
Duration (ms) 100 ms Change	No. of GCs	Percentage
100 - 200	2	100.0%



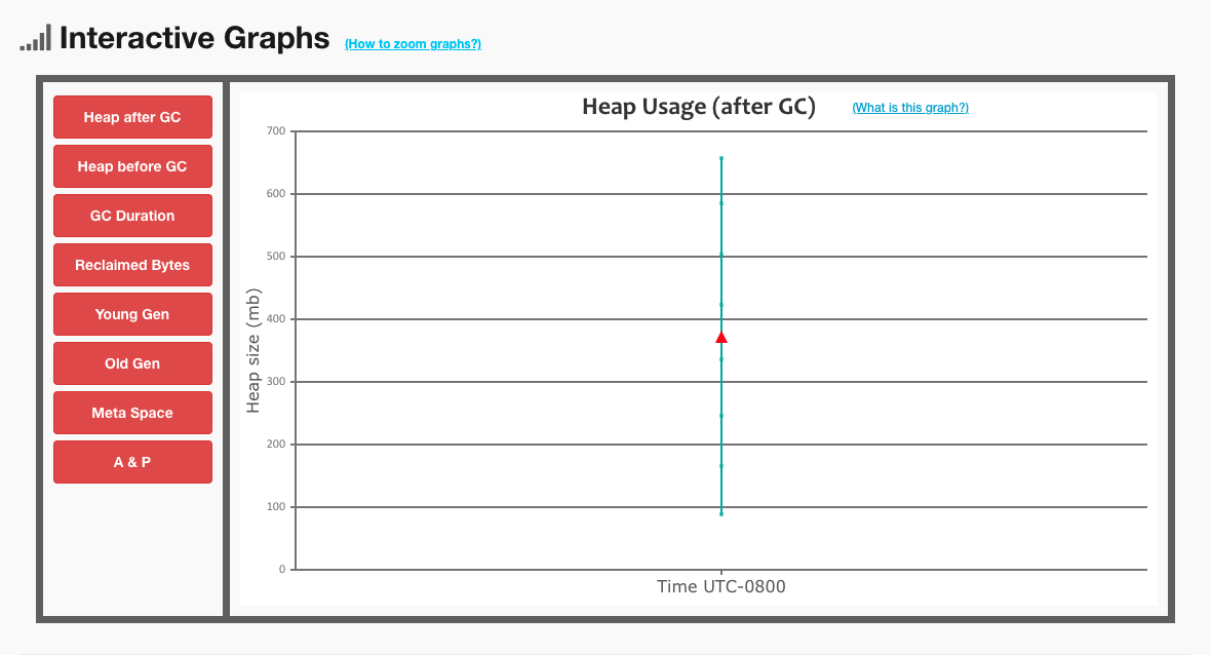
-Xmx4g -Xms4g 时，GC 暂停时间最长，平均 GC 暂停时间为 150ms，最长 GC 暂停时间为 170ms。100-200 时间段，占比较高。

2）堆内存使用情况

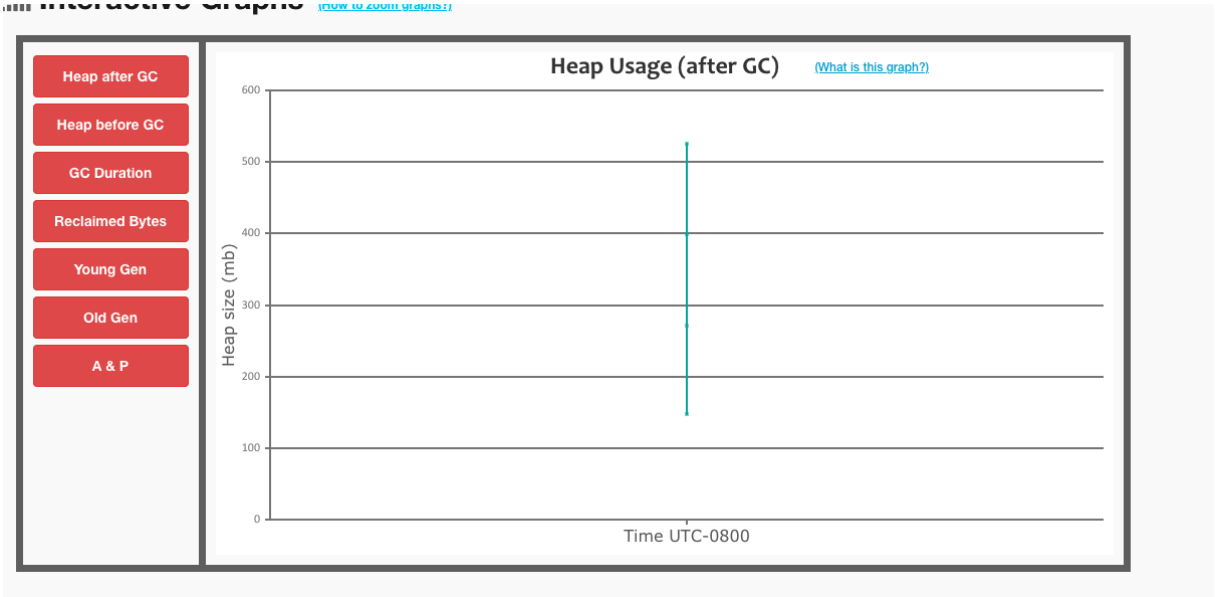
-Xmx512m -Xms512m



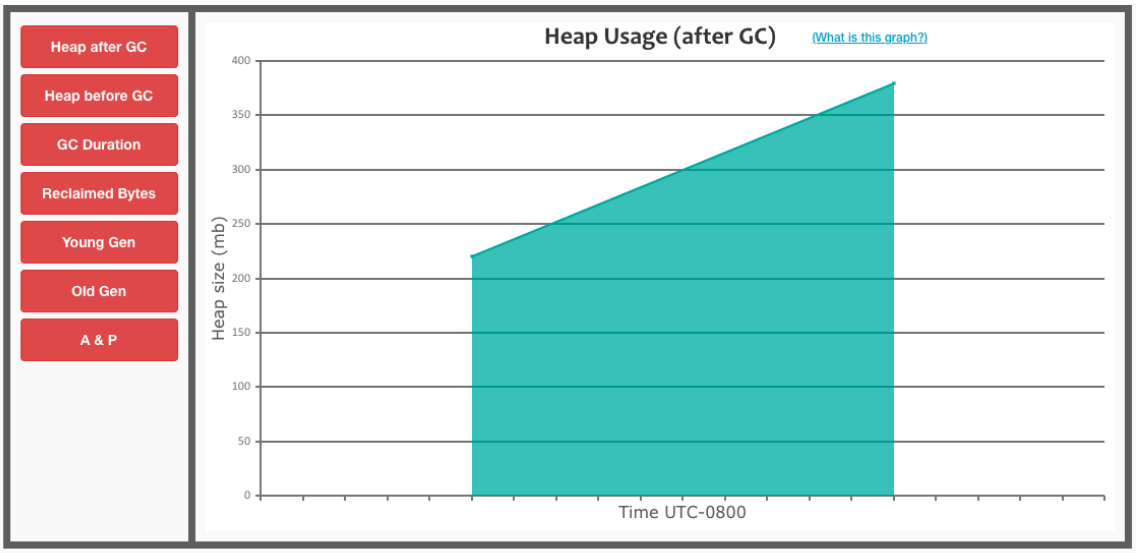
-Xmx1g -Xms1g



-Xmx2g -Xms2g

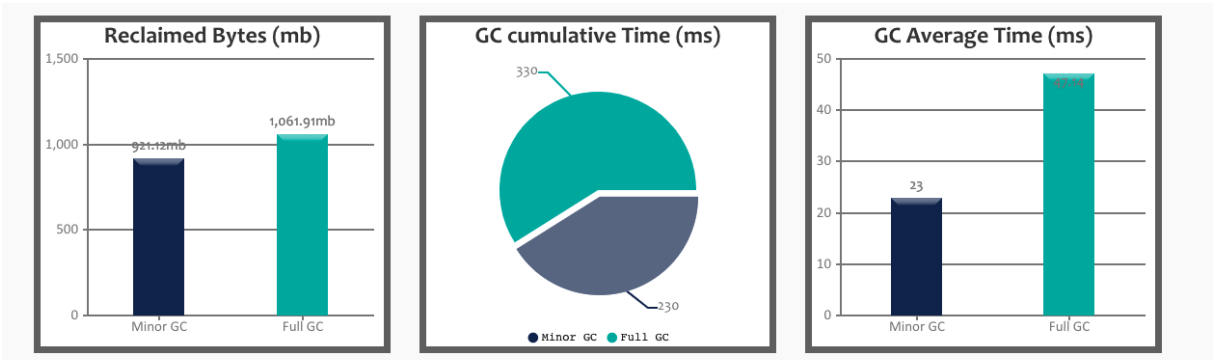


-Xmx4g -Xms4g



3) GC 情况统计

-Xmx512m -Xms512m



Total GC stats

Total GC count	17
Total reclaimed bytes	1.94 gb
Total GC time	560 ms
Avg GC time	32.9 ms
GC avg time std dev	15.2 ms
GC min/max time	0 / 50.0 ms
GC Interval avg time	53.0 ms

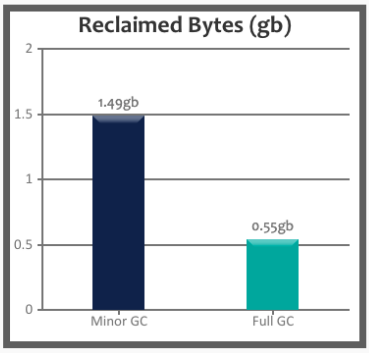
Minor GC stats

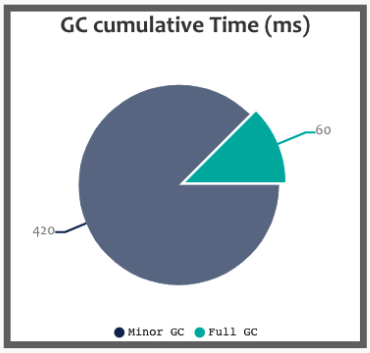
Minor GC count	10
Minor GC reclaimed	921.12 mb
Minor GC total time	230 ms
Minor GC avg time	23.0 ms
Minor GC avg time std dev	11.9 ms
Minor GC min/max time	0 / 30.0 ms
Minor GC Interval avg	77.0 ms

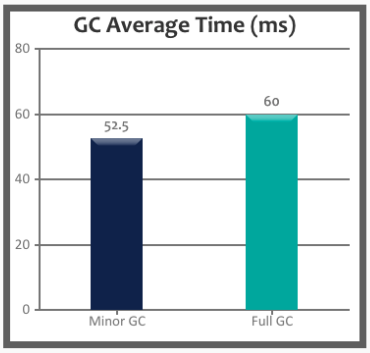
Full GC stats

Full GC Count	7
Full GC reclaimed	1.04 gb
Full GC total time	330 ms
Full GC avg time	47.1 ms
Full GC avg time std dev	4.52 ms
Full GC min/max time	40.0 ms / 50.0 ms
Full GC Interval avg	83.0 ms

-Xmx1g -Xms1g







Total GC stats

Total GC count	9
Total reclaimed bytes	2.04 gb
Total GC time	480 ms
Avg GC time	53.3 ms
GC avg time std dev	6.67 ms
GC min/max time	40.0 ms / 60.0 ms
GC Interval avg time	97.0 ms

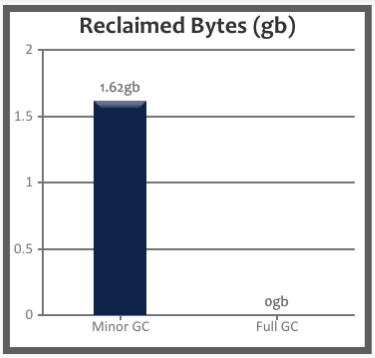
Minor GC stats

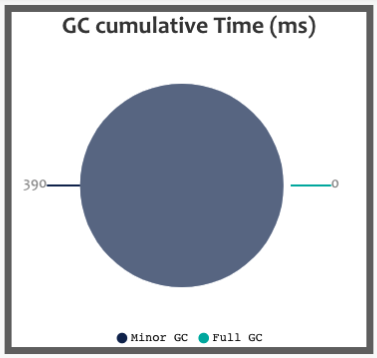
Minor GC count	8
Minor GC reclaimed	1.49 gb
Minor GC total time	420 ms
Minor GC avg time	52.5 ms
Minor GC avg time std dev	6.61 ms
Minor GC min/max time	40.0 ms / 60.0 ms
Minor GC Interval avg	98.0 ms

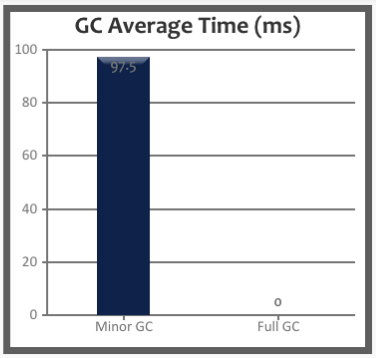
Full GC stats

Full GC Count	1
Full GC reclaimed	558.11 mb
Full GC total time	60.0 ms
Full GC avg time	60.0 ms
Full GC avg time std dev	0
Full GC min/max time	60.0 ms / 60.0 ms
Full GC Interval avg	n/a

-Xmx2g -Xms2g







Total GC stats

Total GC count	4
Total reclaimed bytes	n/a
Total GC time	390 ms
Avg GC time	97.5 ms
GC avg time std dev	13.0 ms
GC min/max time	90.0 ms / 120 ms
GC Interval avg time	187 ms

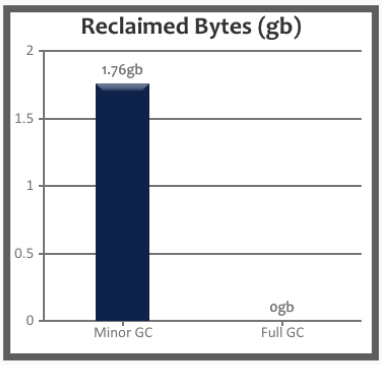
Minor GC stats

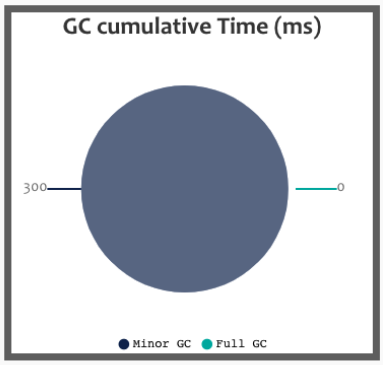
Minor GC count	4
Minor GC reclaimed	1.62 gb
Minor GC total time	390 ms
Minor GC avg time	97.5 ms
Minor GC avg time std dev	13.0 ms
Minor GC min/max time	90.0 ms / 120 ms
Minor GC Interval avg	187 ms

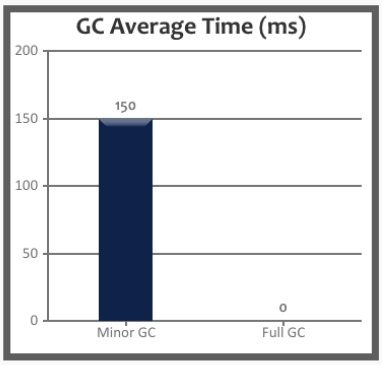
Full GC stats

Full GC Count	0
Full GC reclaimed	n/a
Full GC total time	n/a
Full GC avg time	n/a
Full GC avg time std dev	n/a
Full GC min/max time	n/a
Full GC Interval avg	n/a

-Xmx4g -Xms4g







Total GC stats

Total GC count	2
Total reclaimed bytes	n/a
Total GC time	300 ms
Avg GC time	150 ms
GC avg time std dev	20.0 ms
GC min/max time	130 ms / 170 ms
GC Interval avg time	325 ms

Minor GC stats

Minor GC count	2
Minor GC reclaimed	1.76 gb
Minor GC total time	300 ms
Minor GC avg time	150 ms
Minor GC avg time std dev	20.0 ms
Minor GC min/max time	130 ms / 170 ms
Minor GC Interval avg	325 ms

Full GC stats

Full GC Count	0
Full GC reclaimed	n/a
Full GC total time	n/a
Full GC avg time	n/a
Full GC avg time std dev	n/a
Full GC min/max time	n/a
Full GC Interval avg	n/a

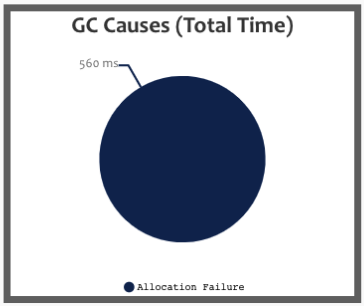
4) GC 原因

-Xmx512m -Xms512m

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	17	32.9 ms	50.0 ms	560 ms

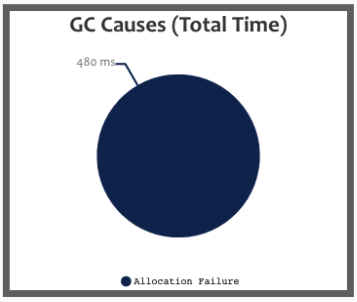


-Xmx1g -Xms1g

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	9	53.3 ms	60.0 ms	480 ms

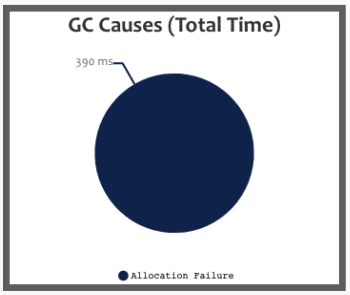


-Xmx2g -Xms2g

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	4	97.5 ms	120 ms	390 ms

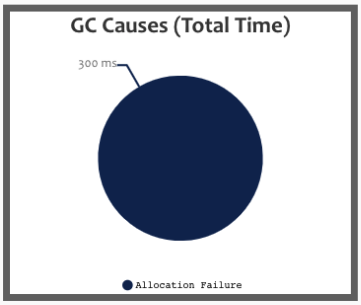


-Xmx4g -Xms4g

GC Causes

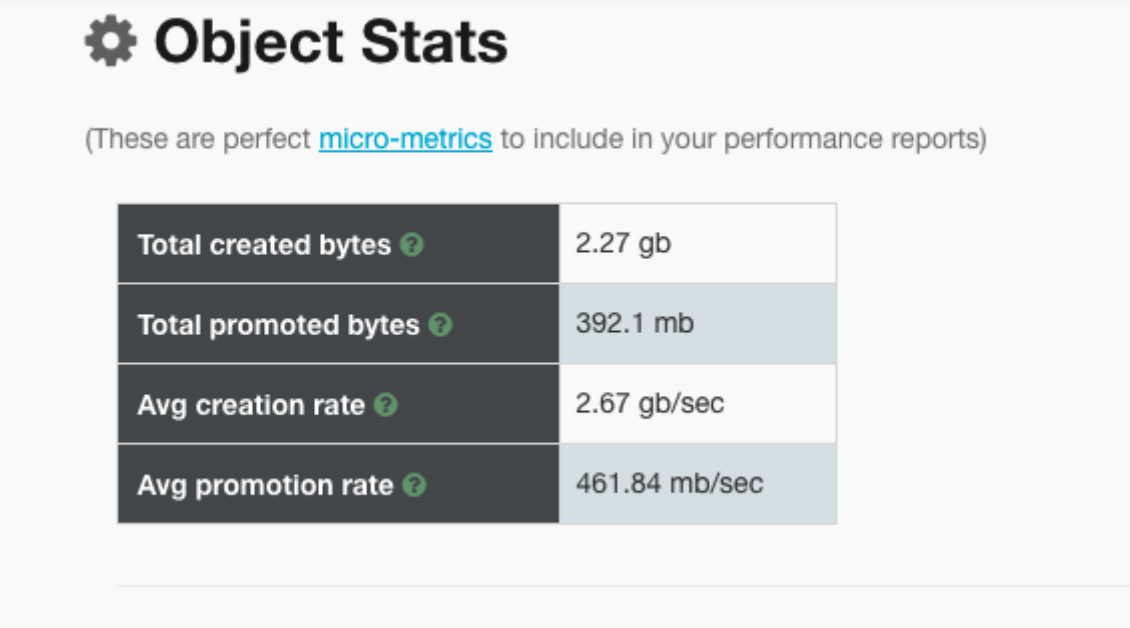
(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	2	150 ms	170 ms	300 ms

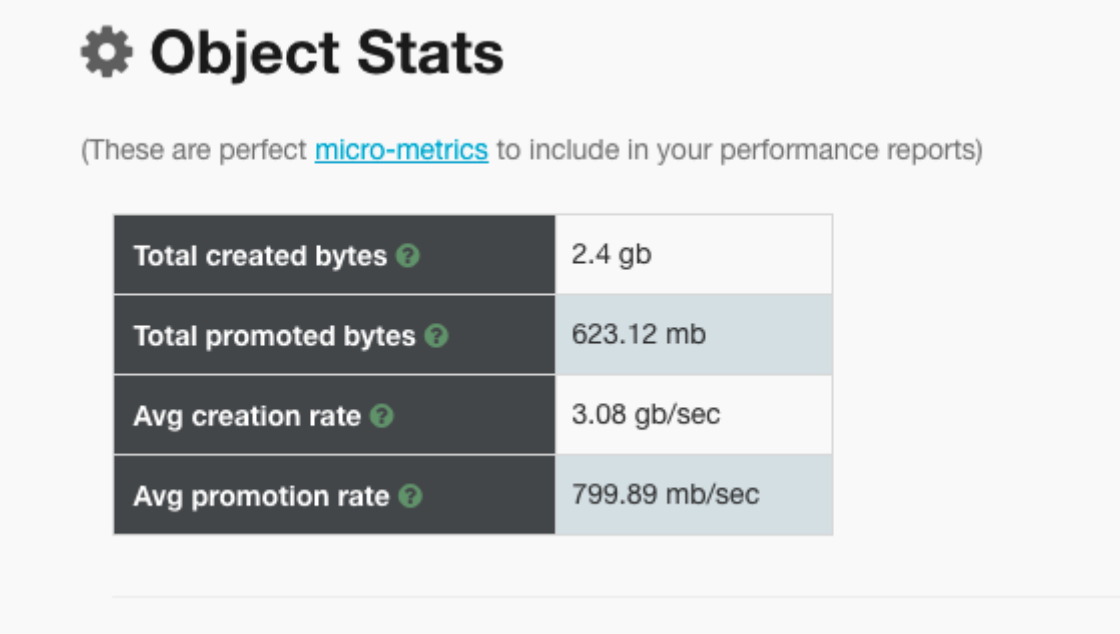


5) 内存分配速度

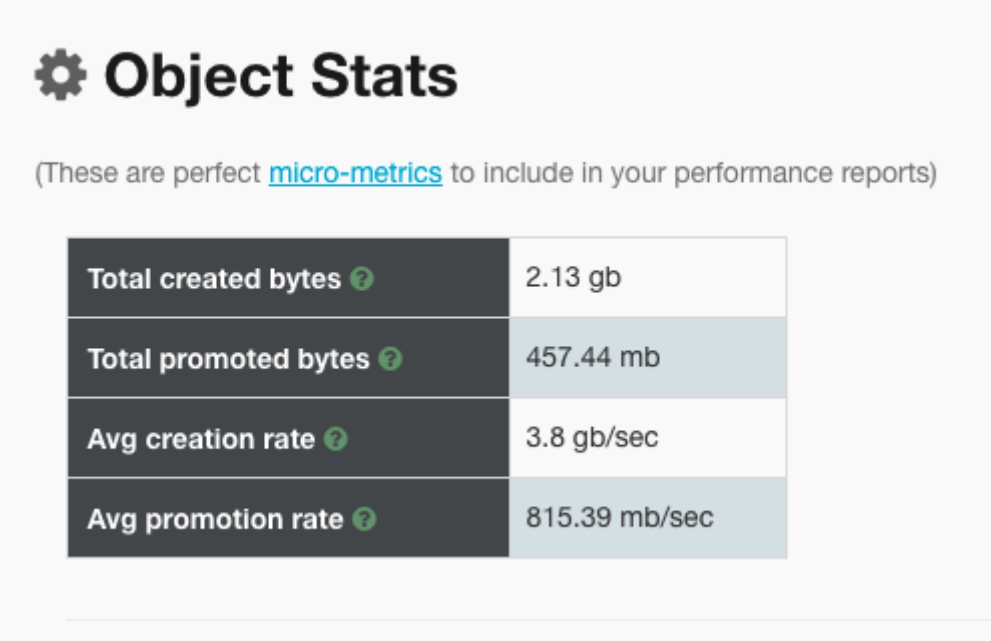
-Xmx512m -Xms512m



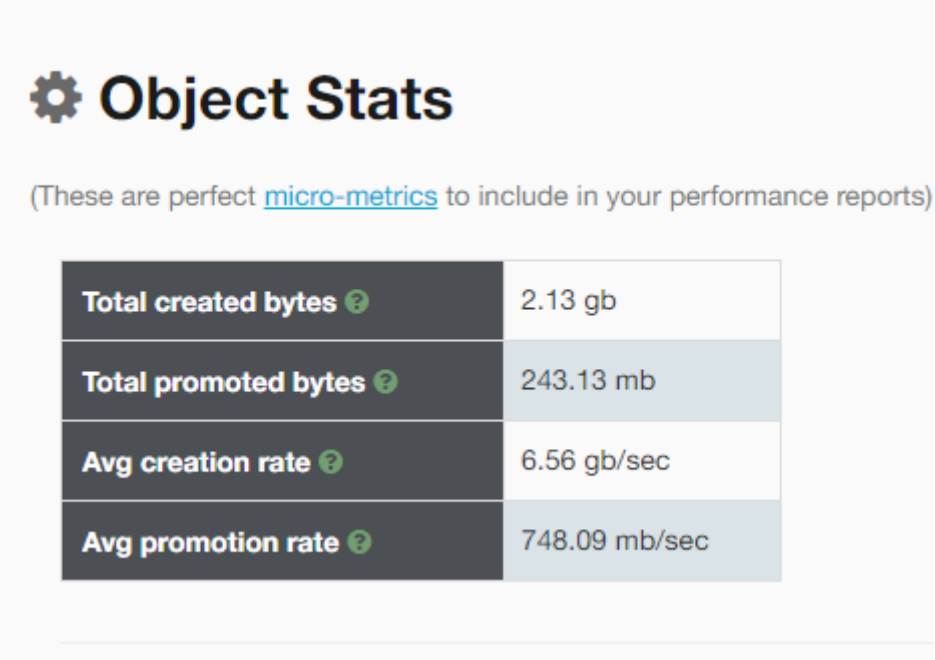
-Xmx1g -Xms1g



-Xmx2g -Xms2g



-Xmx4g -Xms4g

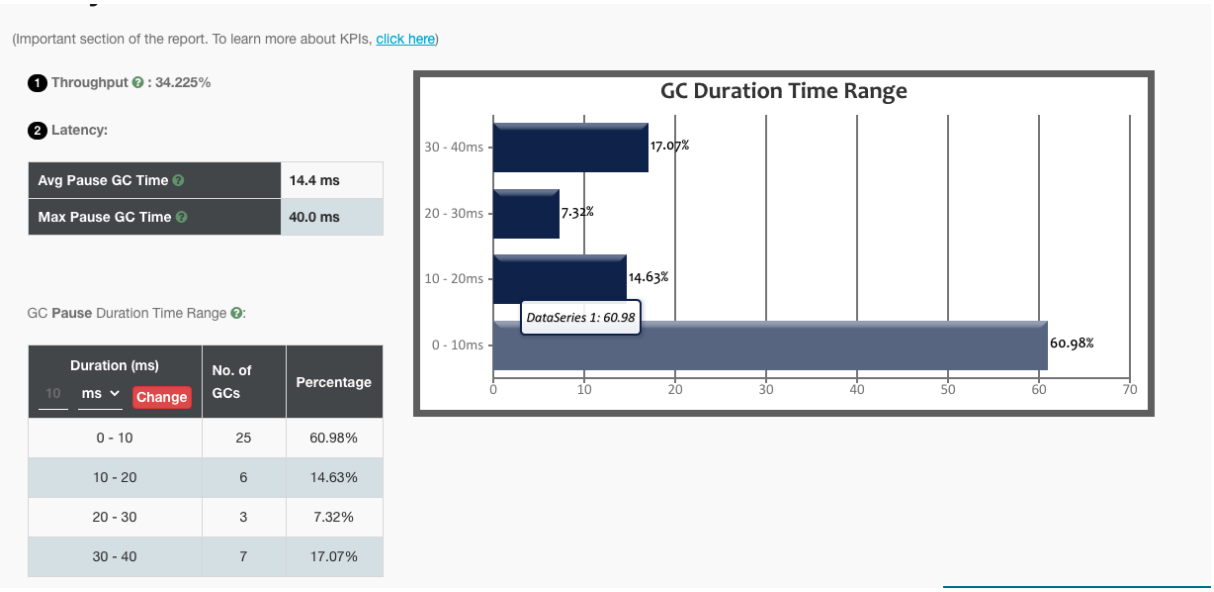


设置堆内存大小为 512m 时，发生了 17 次 GC，其中 Minor GC 10 次，full GC7 次。发生 Full GC 的平均时间时间和累计时间均大于 Minor GC。这是由于 Minor GC 用于 young 区的回收，而 Full GC 对 young 区及 old 区同时回收。设置不同堆内存大小发现，堆内存设置越大，Minor GC 与 Full GC 发生次数越少，在堆内存设置 2g 及 4g 情况下， 没有发生 Full GC。在分析 GC 原因时，发现所有的 GC 发生都是因为分配失败造成，引起 GC 的原因是新生代区没有足够的空间来存储新对象了。查看内存分配速率发现，在堆内存为 512m 时，平均提升率（新生代晋级到老年代的速率）比堆内存为 1g、

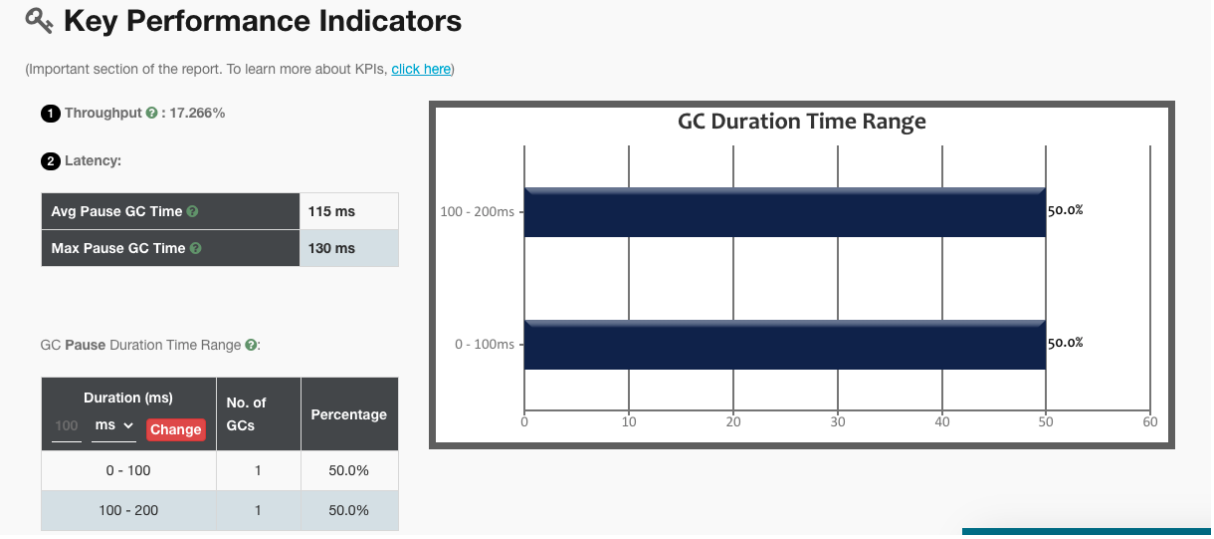
2g、4g 小，当堆内存为 1g 时，提升数据量达到最高为 623.12mb。

3. 并行 GC 分析

1）GC 暂停时间



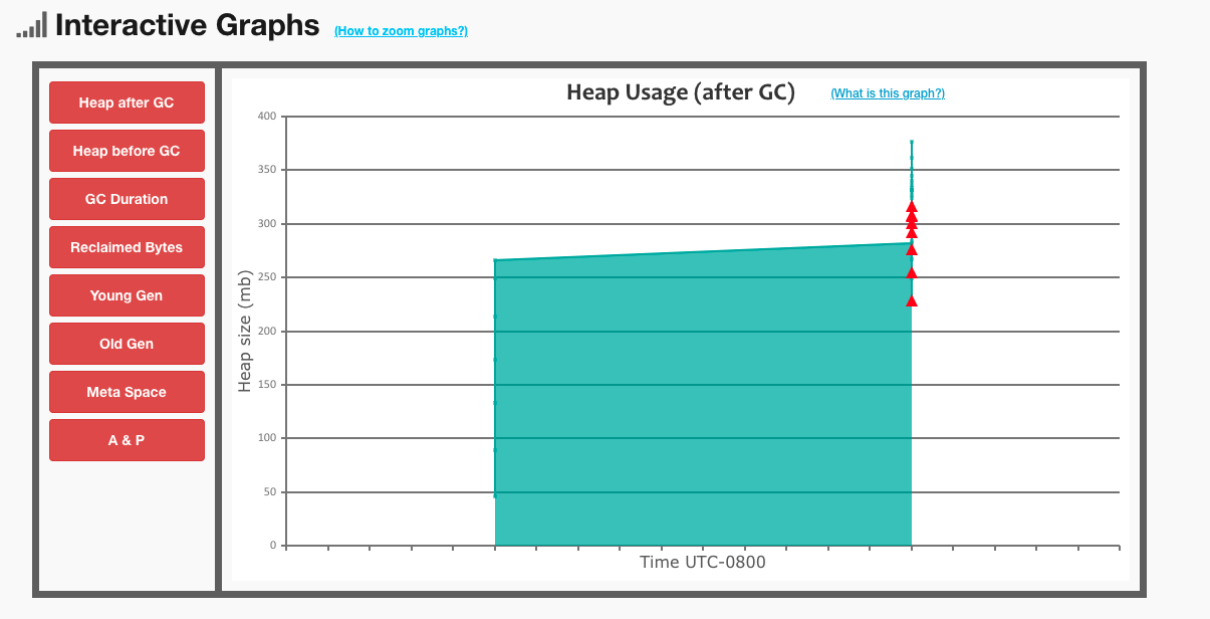
-Xmx512m -Xms512m 时，GC 暂停时间最优，平均 GC 暂停时间为 14.4ms，最长 GC 暂停时间为 40ms。0-10 时间段内占比较高。



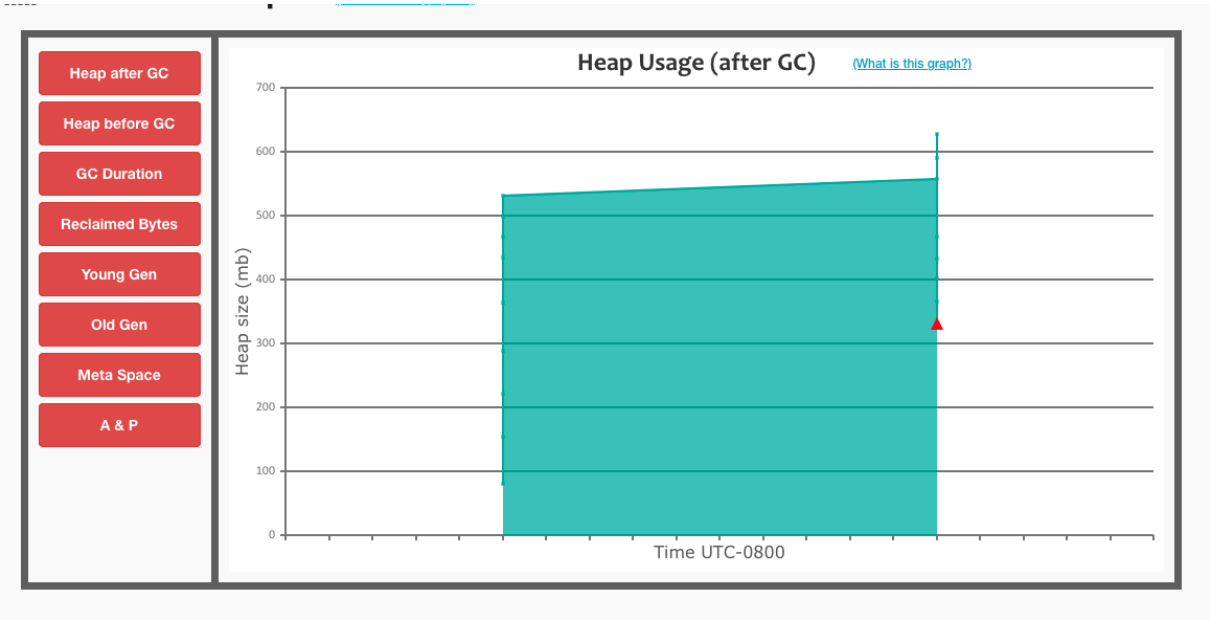
-Xmx4g -Xms4g 时，GC 暂停时间最长，平均 GC 暂停时间为 115ms，最长 GC 暂停时间为 130ms。0-100ms 与 100-200ms 占比相同。

2）堆内存使用情况

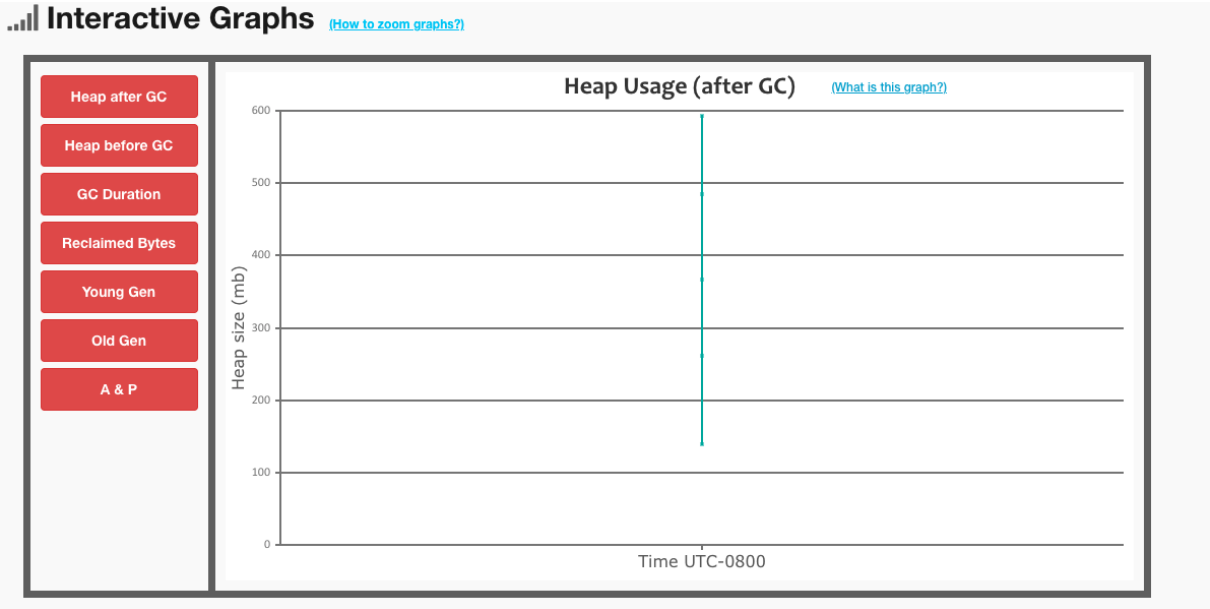
-Xmx512m -Xms512m



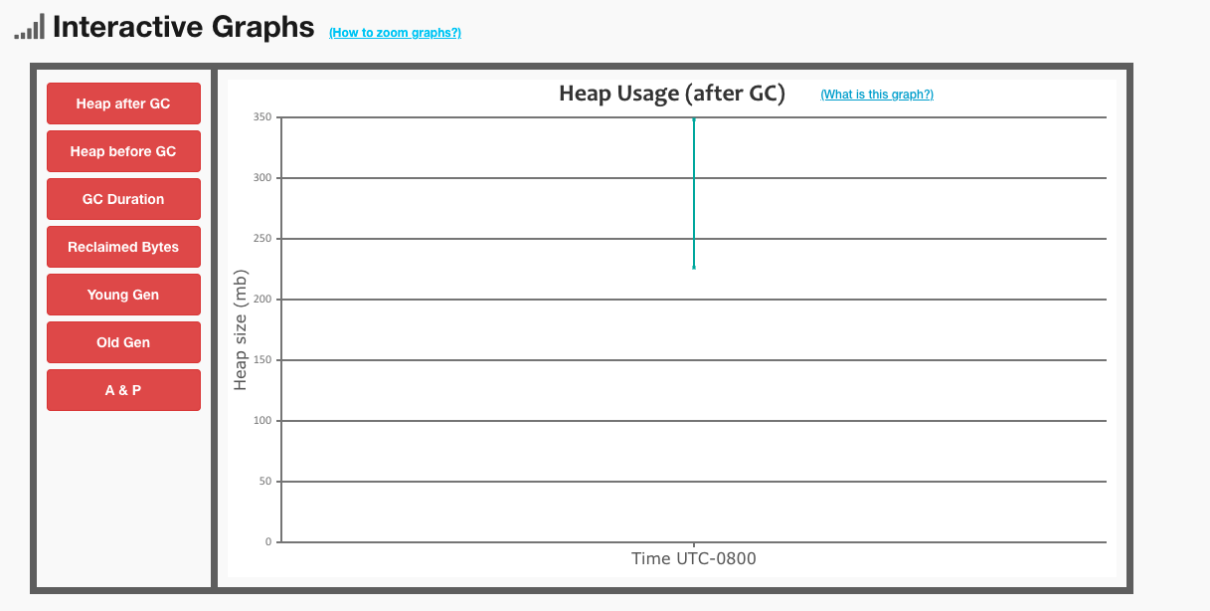
-Xmx1g -Xms1g



-Xmx2g -Xms2g

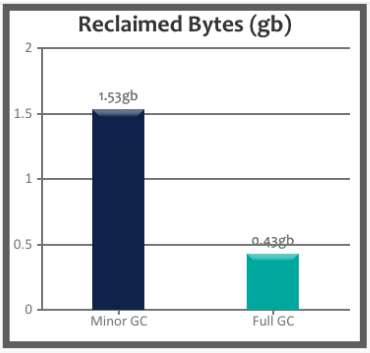


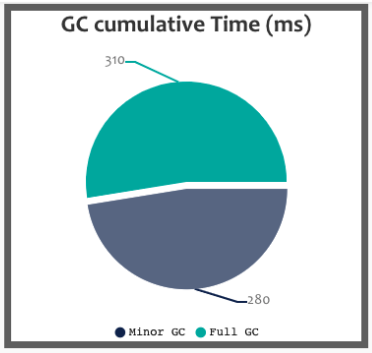
-Xmx4g -Xms4g

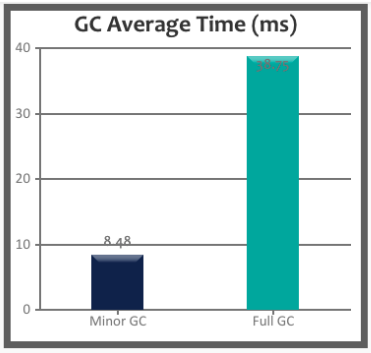


3) GC 情况统计

-Xmx512m -Xms512m







Total GC stats

Total GC count	41
Total reclaimed bytes	1.96 gb
Total GC time	590 ms
Avg GC time	14.4 ms
GC avg time std dev	14.7 ms
GC min/max time	0 / 40.0 ms
GC Interval avg time	22.0 ms

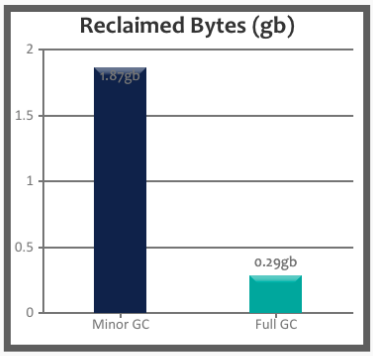
Minor GC stats

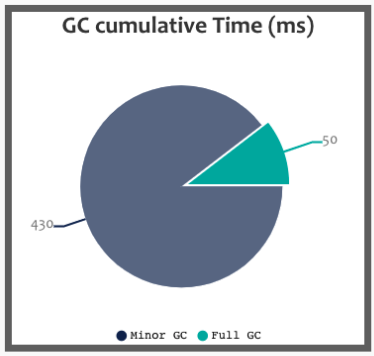
Minor GC count	33
Minor GC reclaimed	1.53 gb
Minor GC total time	280 ms
Minor GC avg time	8.48 ms
Minor GC avg time std dev	9.25 ms
Minor GC min/max time	0 / 30.0 ms
Minor GC Interval avg	27.0 ms

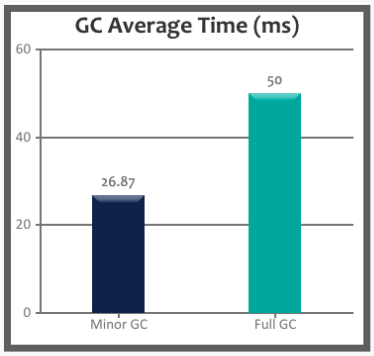
Full GC stats

Full GC Count	8
Full GC reclaimed	437.75 mb
Full GC total time	310 ms
Full GC avg time	38.7 ms
Full GC avg time std dev	3.31 ms
Full GC min/max time	30.0 ms / 40.0 ms
Full GC Interval avg	79.0 ms

-Xmx1g -Xms1g







Total GC stats

Total GC count	17
Total reclaimed bytes	2.16 gb
Total GC time	480 ms
Avg GC time	28.2 ms
GC avg time std dev	15.0 ms
GC min/max time	10.0 ms / 50.0 ms
GC Interval avg time	51.0 ms

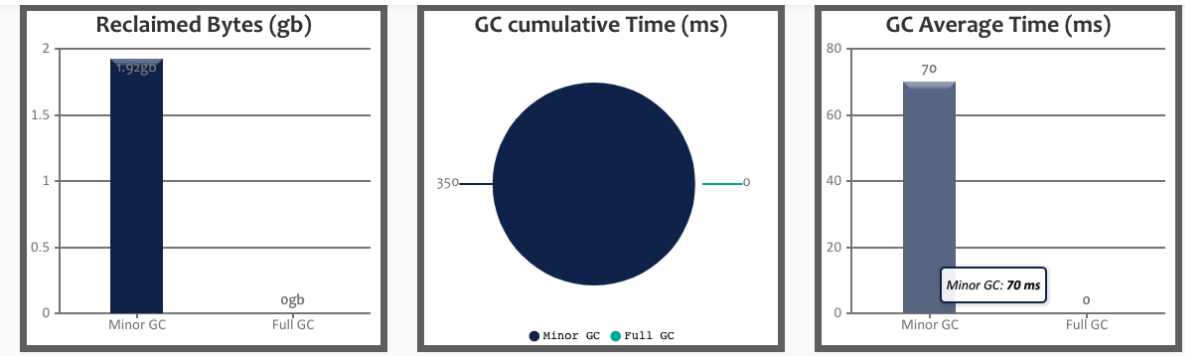
Minor GC stats

Minor GC count	16
Minor GC reclaimed	1.87 gb
Minor GC total time	430 ms
Minor GC avg time	26.9 ms
Minor GC avg time std dev	14.5 ms
Minor GC min/max time	10.0 ms / 50.0 ms
Minor GC Interval avg	55.0 ms

Full GC stats

Full GC Count	1
Full GC reclaimed	296.02 mb
Full GC total time	50.0 ms
Full GC avg time	50.0 ms
Full GC avg time std dev	0
Full GC min/max time	50.0 ms / 50.0 ms
Full GC Interval avg	n/a

-Xmx2g -Xms2g



Total GC stats

Total GC count	5
Total reclaimed bytes	n/a
Total GC time	350 ms
Avg GC time	70.0 ms
GC avg time std dev	15.5 ms
GC min/max time	60.0 ms / 100 ms
GC Interval avg time	153 ms

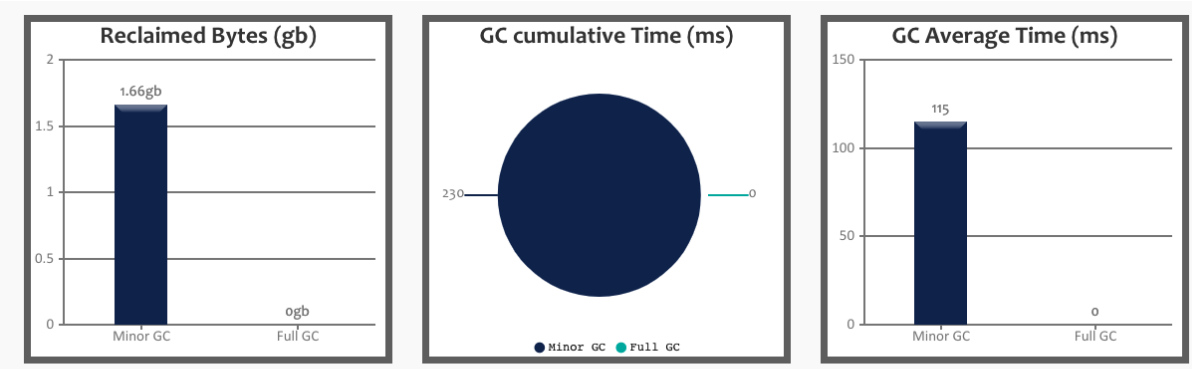
Minor GC stats

Minor GC count	5
Minor GC reclaimed	1.92 gb
Minor GC total time	350 ms
Minor GC avg time	70.0 ms
Minor GC avg time std dev	15.5 ms
Minor GC min/max time	60.0 ms / 100 ms
Minor GC Interval avg	153 ms

Full GC stats

Full GC Count	0
Full GC reclaimed	n/a
Full GC total time	n/a
Full GC avg time	n/a
Full GC avg time std dev	n/a
Full GC min/max time	n/a
Full GC Interval avg	n/a

-Xmx4g -Xms4g



Total GC stats

Total GC count	2
Total reclaimed bytes	n/a
Total GC time	230 ms
Avg GC time	115 ms
GC avg time std dev	15.0 ms
GC min/max time	100 ms / 130 ms
GC Interval avg time	278 ms

Minor GC stats

Minor GC count	2
Minor GC reclaimed	1.66 gb
Minor GC total time	230 ms
Minor GC avg time	115 ms
Minor GC avg time std dev	15.0 ms
Minor GC min/max time	100 ms / 130 ms
Minor GC Interval avg	278 ms

Full GC stats

Full GC Count	0
Full GC reclaimed	n/a
Full GC total time	n/a
Full GC avg time	n/a
Full GC avg time std dev	n/a
Full GC min/max time	n/a
Full GC Interval avg	n/a

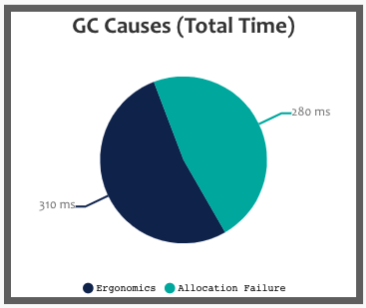
4) GC 原因

-Xmx512m -Xms512m

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Ergonomics	8	38.7 ms	40.0 ms	310 ms
Allocation Failure	33	8.48 ms	30.0 ms	280 ms

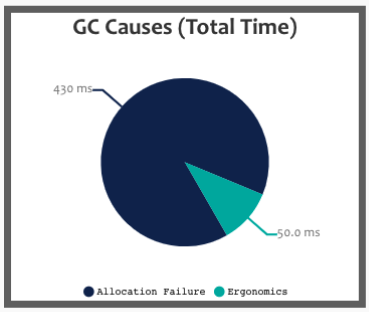


-Xmx1g -Xms1g

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	16	26.9 ms	50.0 ms	430 ms
Ergonomics	1	50.0 ms	50.0 ms	50.0 ms

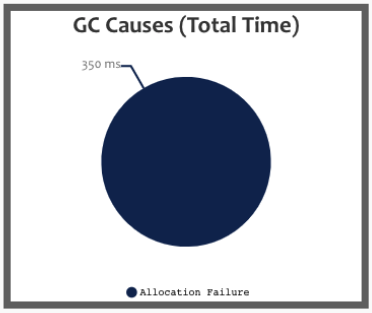


-Xmx2g -Xms2g

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	5	70.0 ms	100 ms	350 ms

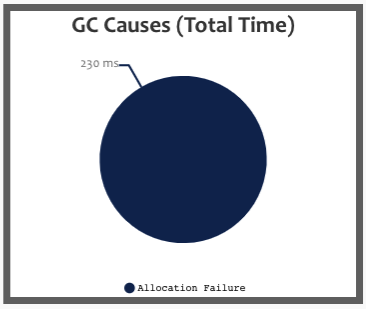


-Xmx4g -Xms4g

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	2	115 ms	130 ms	230 ms



5）内存分配速度

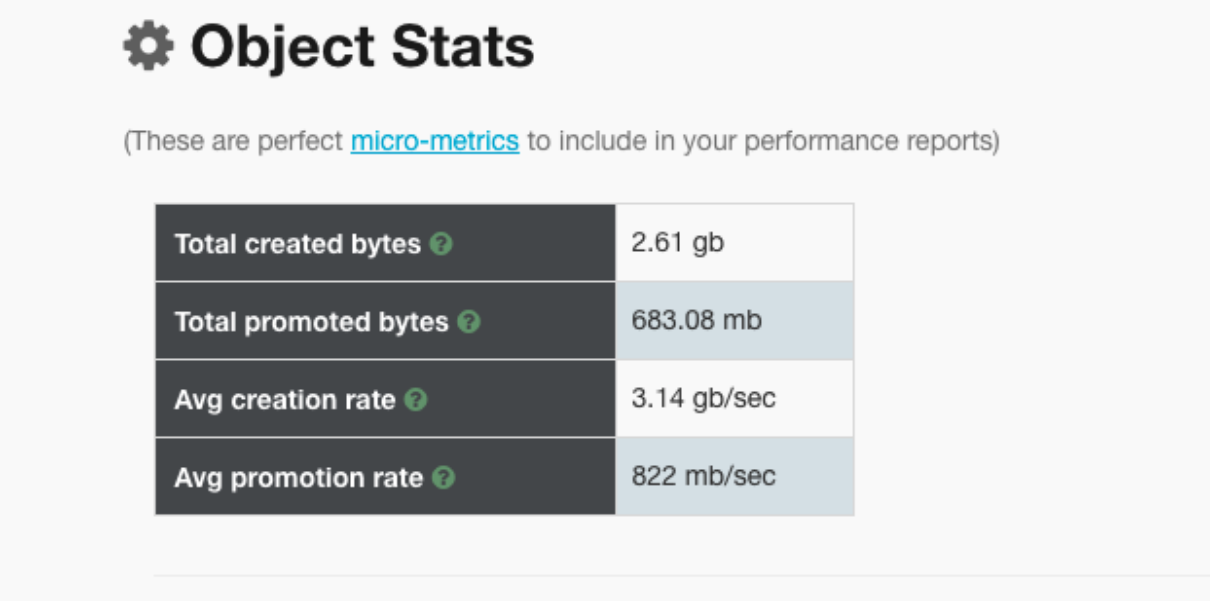
-Xmx512m -Xms512m

Object Stats

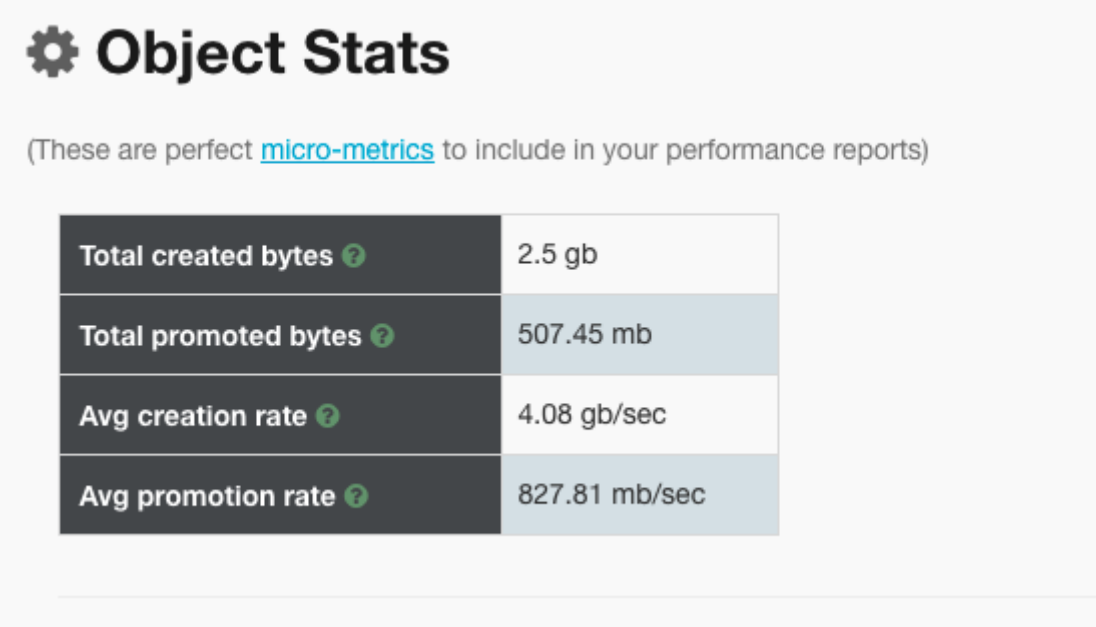
(These are perfect micro-metrics to include in your performance reports)

Total created bytes	2.27 gb
Total promoted bytes	555.1 mb
Avg creation rate	2.53 gb/sec
Avg promotion rate	618.84 mb/sec

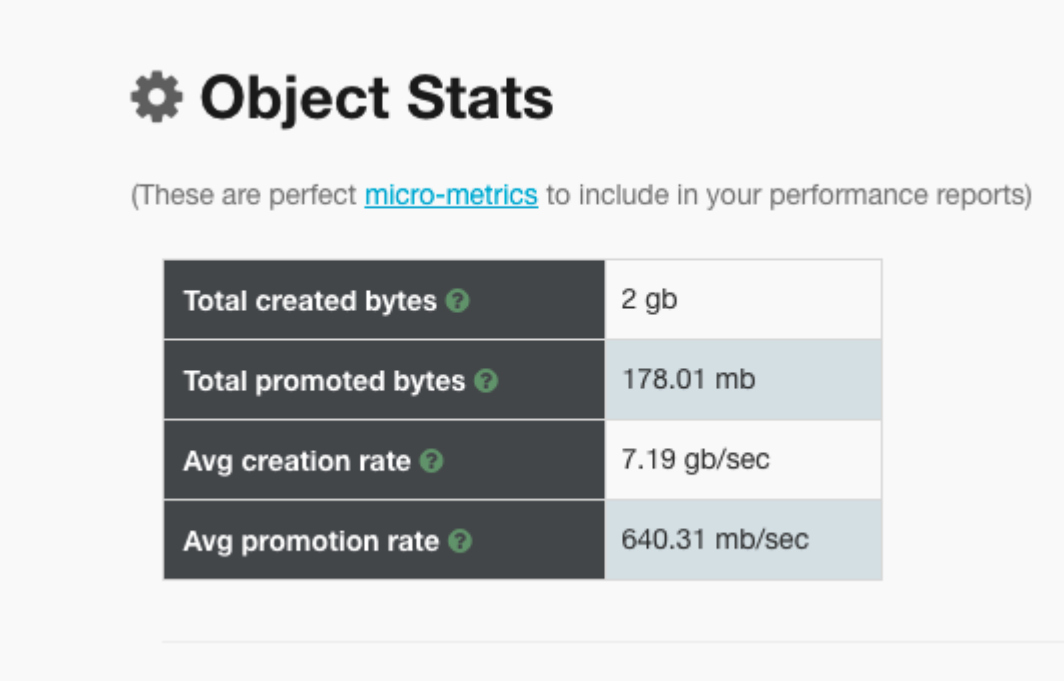
-Xmx1g -Xms1g



-Xmx2g -Xms2g



-Xmx4g -Xms4g



Object Stats

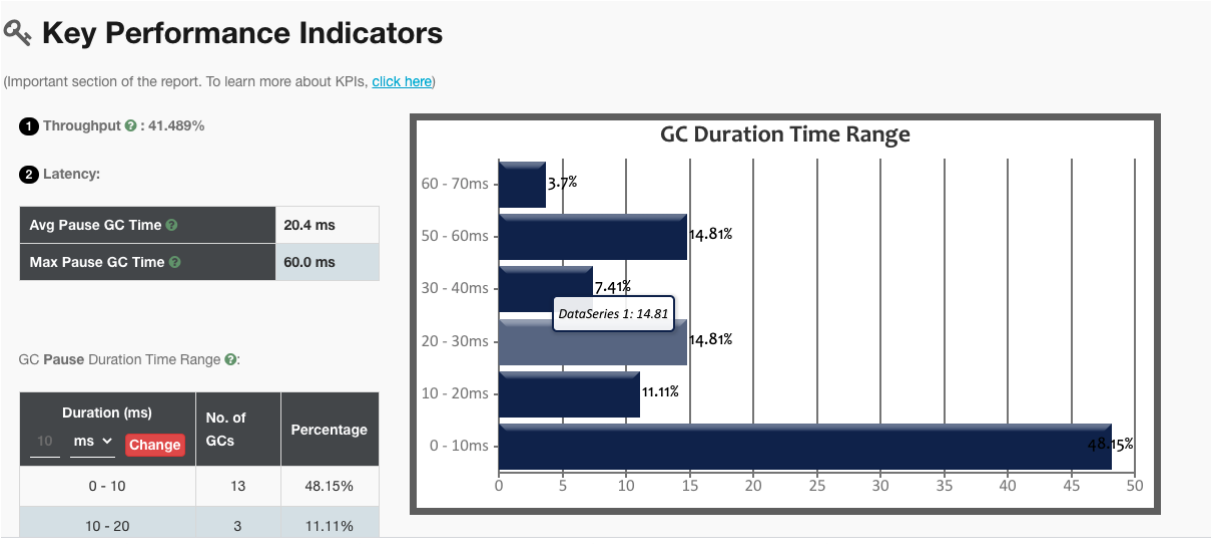
(These are perfect micro-metrics to include in your performance reports)

Total created bytes	2 gb
Total promoted bytes	178.01 mb
Avg creation rate	7.19 gb/sec
Avg promotion rate	640.31 mb/sec

设置堆内存大小为 512m 时，发生了 41 次 GC，其中 Minor GC 33 次，full GC 8 次。发生 Full GC 的平均时间时间和累计时间远超于 Minor GC，平均 Full GC 时间为 38.8ms。设置不同堆内存大小发现，堆内存设置越大，Minor GC 与 Full GC 发生次数越少，在堆内存设置 2g 及 4g 情况下， 没有发生 Full GC。在分析 GC 原因时，发现在设置 1g 堆内存情况下，发生了一次自动调整 GC，这是因为 Parallel GC 在 Full GC 前会发生一次判断，如果要分配的内存>Eden 区的一半，会直接把分配的内存放入老年代中，Ergonomics 负责自动的调节 GC 暂停时间和吞吐量之间的平衡。

4. CMS GC 分析

1）GC 暂停时间



Key Performance Indicators

(Important section of the report. To learn more about KPIs, click here)

1 Throughput : 41.489%

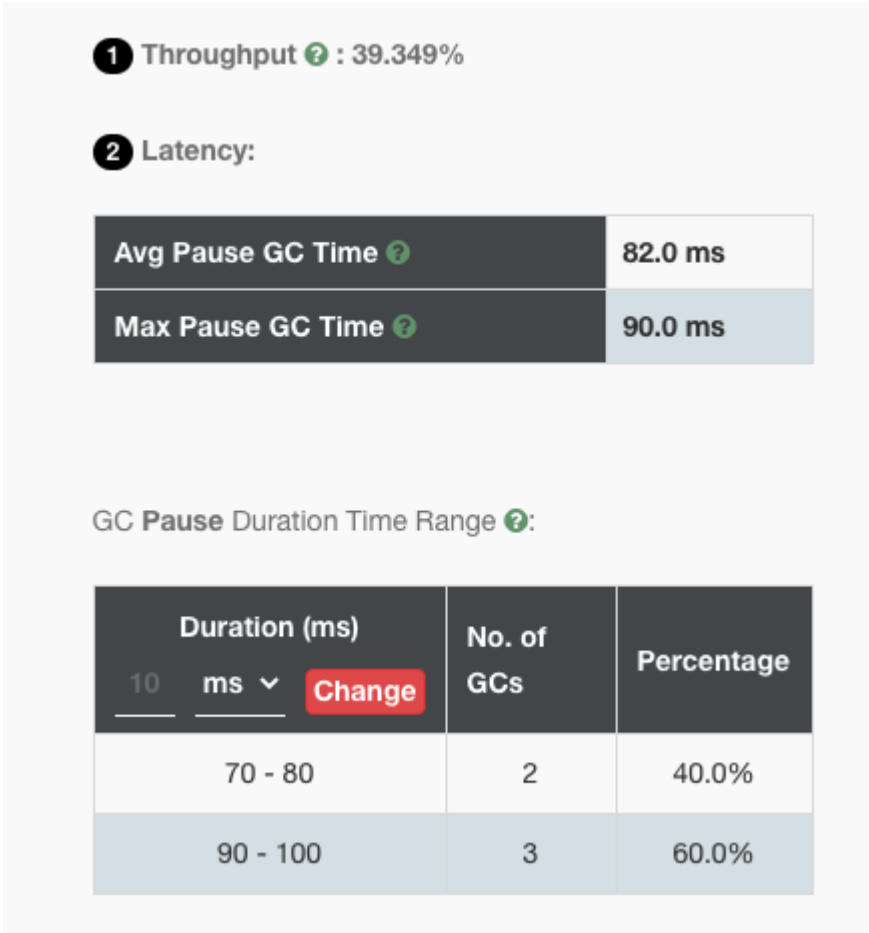
2 Latency:

Avg Pause GC Time	20.4 ms
Max Pause GC Time	60.0 ms

GC Pause Duration Time Range:

Duration (ms) 10 ms Change	No. of GCs	Percentage
0 - 10	13	48.15%
10 - 20	3	11.11%

-Xmx512m -Xms512m 时，GC 暂停时间最优，平均 GC 暂停时间为 20.4ms，最长 GC 暂停时间为 60ms。0-10 时间段内占比较高。



1 Throughput : 39.349%

2 Latency:

Avg Pause GC Time	82.0 ms
Max Pause GC Time	90.0 ms

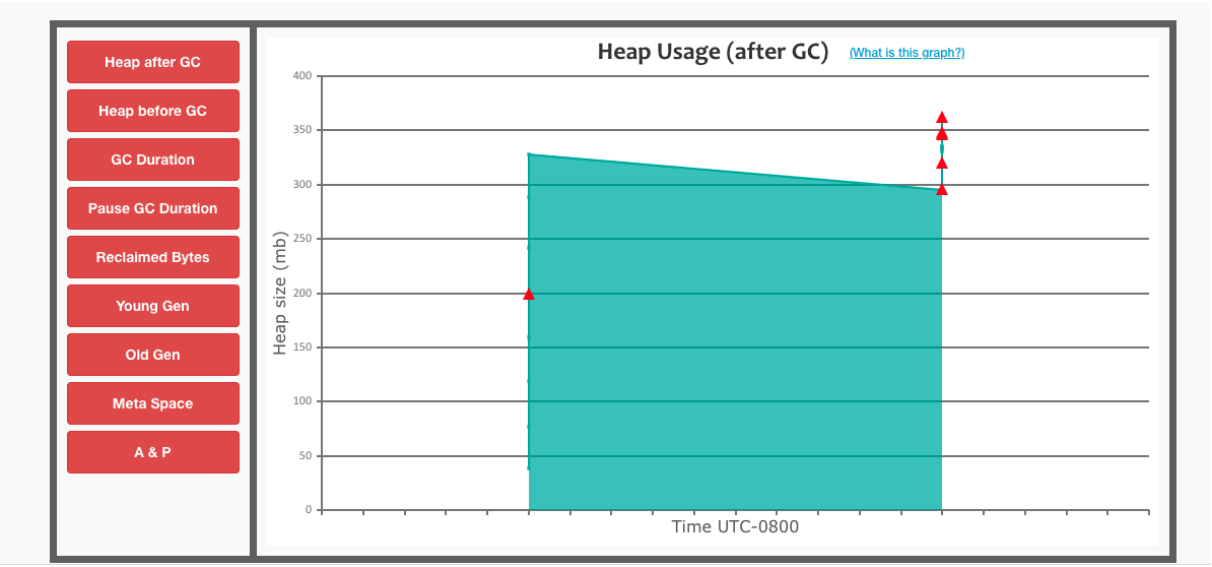
GC Pause Duration Time Range :

Duration (ms) 10 ms Change	No. of GCs	Percentage
70 - 80	2	40.0%
90 - 100	3	60.0%

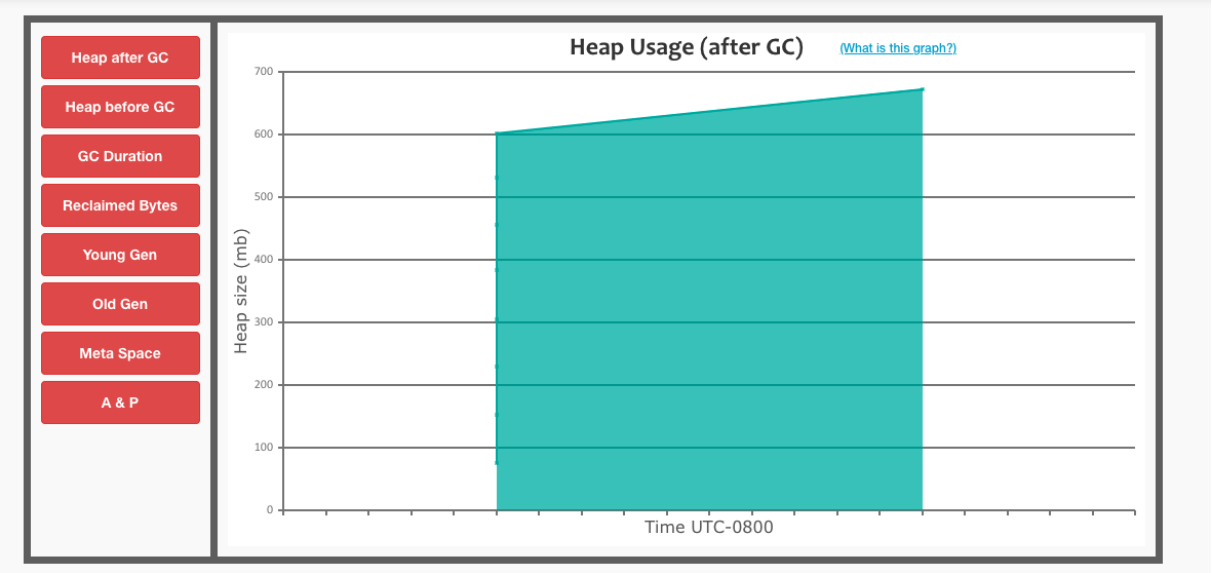
-Xmx4g -Xms4g 时，GC 暂停时间最长，平均 GC 暂停时间为 82ms，最长 GC 暂停时间为 90ms。90-100 时间段，占比较高。

2）堆内存使用情况

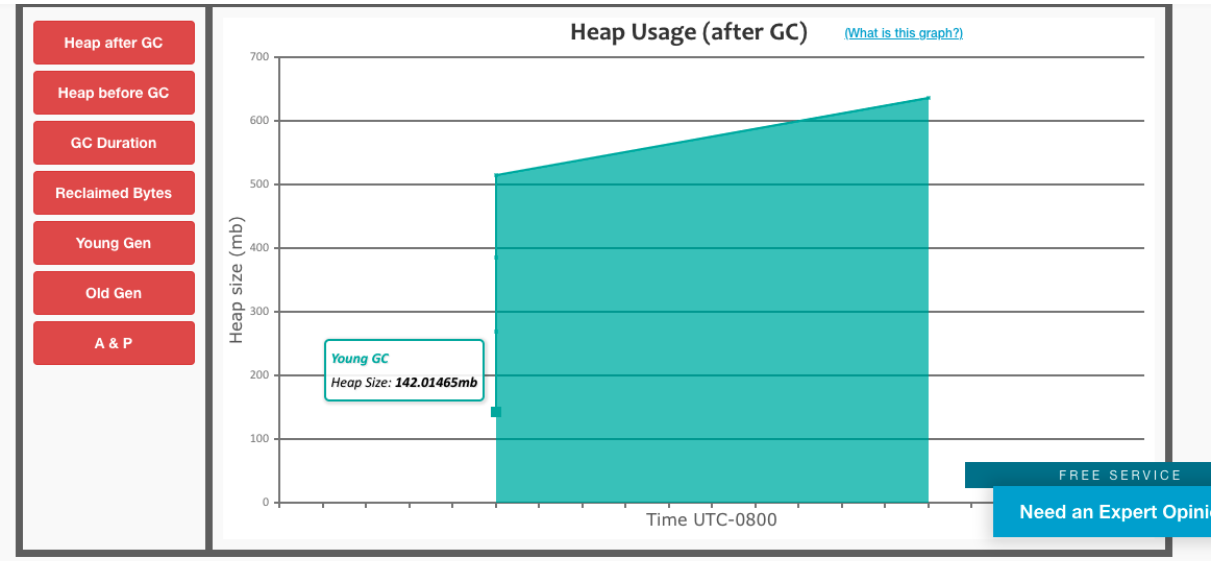
-Xmx512m -Xms512m



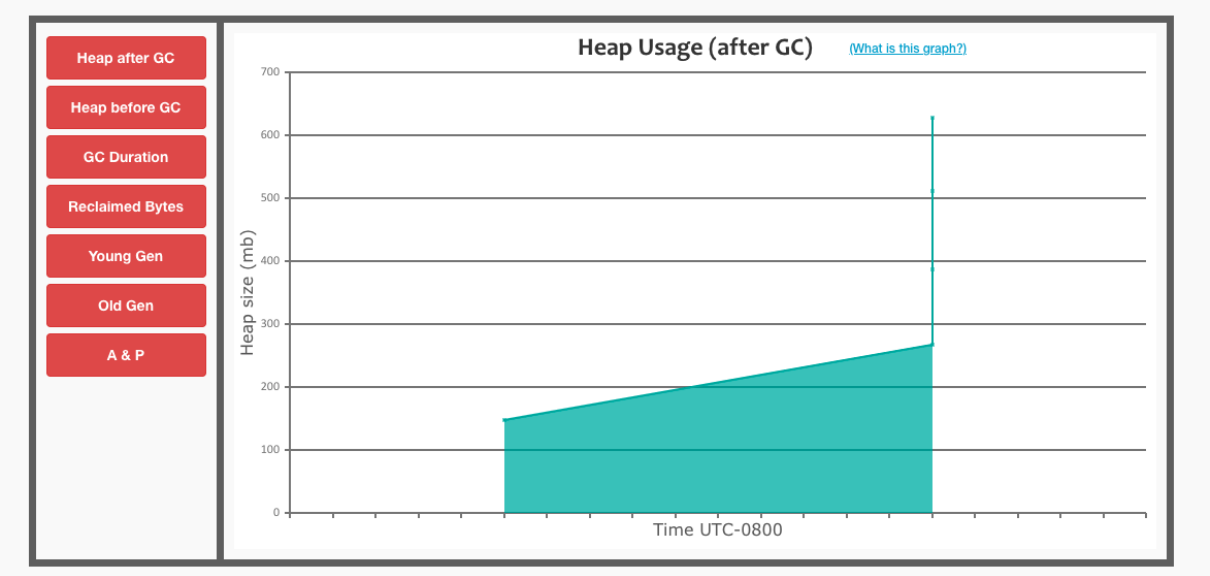
-Xmx1g -Xms1g



-Xmx2g -Xms2g



-Xmx4g -Xms4g

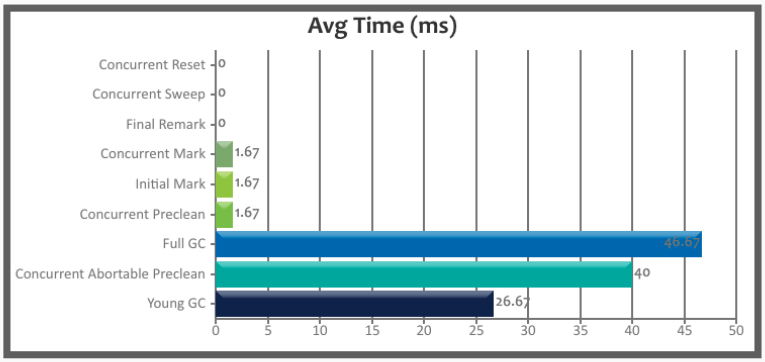


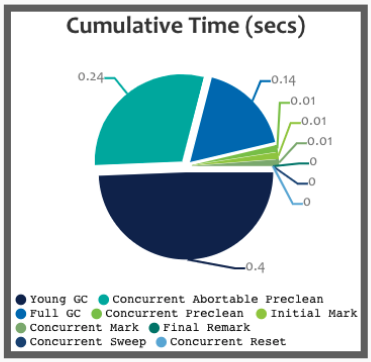
可以看出分配内存越大使用率越低。

3) GC 情况统计

-Xmx512m -Xms512m

CMS Collection Phases Statistics

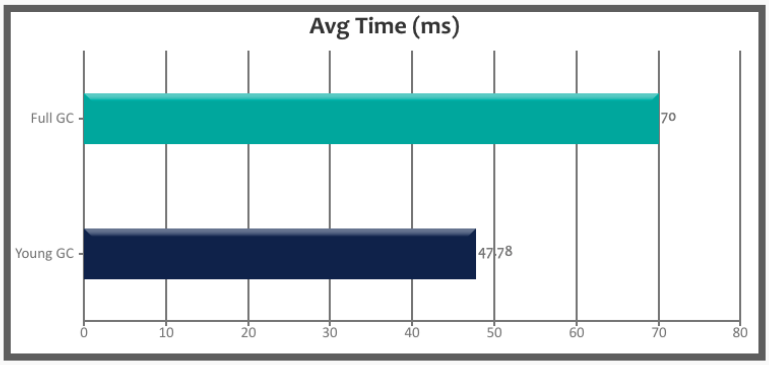


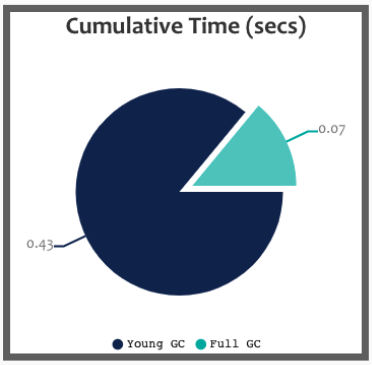


	Young GC	Concurrent Abortable Preclean	Full GC	Concurrent Preclean	Initial Mark	Concurrent Mark	Final Remark	Concurrent Sweep	Concurrent Reset
Total Time	400 ms	240 ms	140 ms	10.0 ms	10.0 ms	10.0 ms	0	0	0
Avg Time	26.7 ms	40.0 ms	46.7 ms	1.67 ms	1.67 ms	1.67 ms	0	0	0
Std Dev Time	17.4 ms	60.8 ms	4.71 ms	3.73 ms	3.73 ms	3.73 ms	0	0	0
Min Time	0	0	40.0 ms	0	0	0	0	0	0
Max Time	60.0 ms	170 ms	50.0 ms	10.0 ms	10.0 ms	10.0 ms	0	0	0
Interval Time	63.0 ms	94.0 ms	159 ms	128 ms	129 ms	129 ms	132 ms	132 ms	132 ms

-Xmx1g -Xms1g

CMS Collection Phases Statistics

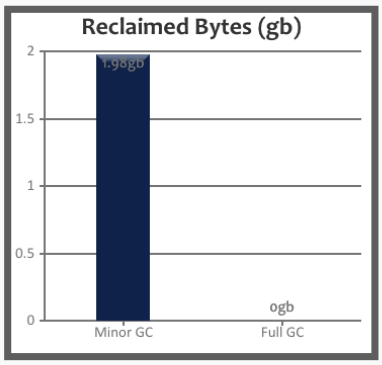


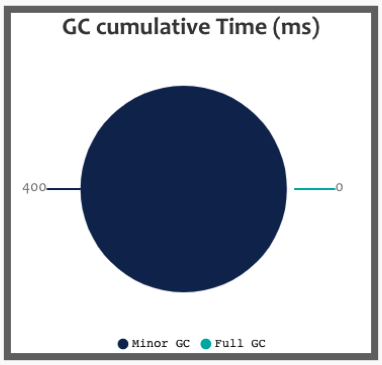


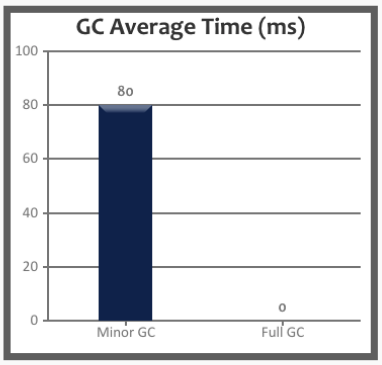
	Young GC	Full GC
Total Time	430 ms	70.0 ms
Avg Time	47.8 ms	70.0 ms
Std Dev Time	7.86 ms	0
Min Time	30.0 ms	70.0 ms
Max Time	60.0 ms	70.0 ms
Interval Time	93.0 ms	n/a
Count	9	1

-Xmx2g -Xms2g

GC Statistics







Total GC stats

Total GC count	5
Total reclaimed bytes	n/a
Total GC time	400 ms
Avg GC time	80.0 ms
GC avg time std dev	14.1 ms
GC min/max time	60.0 ms / 100 ms
GC Interval avg time	166 ms

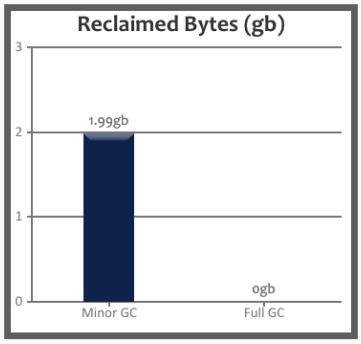
Minor GC stats

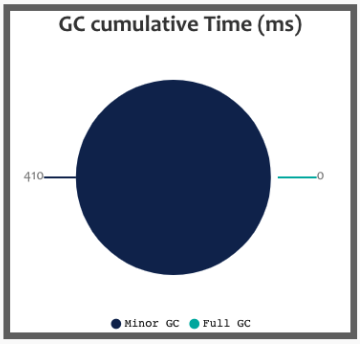
Minor GC count	5
Minor GC reclaimed	1.98 gb
Minor GC total time	400 ms
Minor GC avg time	80.0 ms
Minor GC avg time std dev	14.1 ms
Minor GC min/max time	60.0 ms / 100 ms
Minor GC Interval avg	166 ms

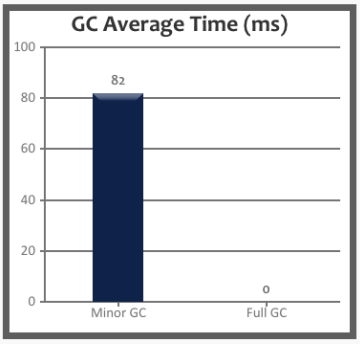
Full GC stats

Full GC Count	0
Full GC reclaimed	n/a
Full GC total time	n/a
Full GC avg time	n/a
Full GC avg time std dev	n/a
Full GC min/max time	n/a
Full GC Interval avg	n/a

-Xmx4g -Xms4g







Total GC stats

Total GC count	5
Total reclaimed bytes	n/a
Total GC time	410 ms
Avg GC time	82.0 ms
GC avg time std dev	9.80 ms
GC min/max time	70.0 ms / 90.0 ms
GC Interval avg time	169 ms

Minor GC stats

Minor GC count	5
Minor GC reclaimed	1.99 gb
Minor GC total time	410 ms
Minor GC avg time	82.0 ms
Minor GC avg time std dev	9.80 ms
Minor GC min/max time	70.0 ms / 90.0 ms
Minor GC Interval avg	169 ms

Full GC stats

Full GC Count	0
Full GC reclaimed	n/a
Full GC total time	n/a
Full GC avg time	n/a
Full GC avg time std dev	n/a
Full GC min/max time	n/a
Full GC Interval avg	n/a

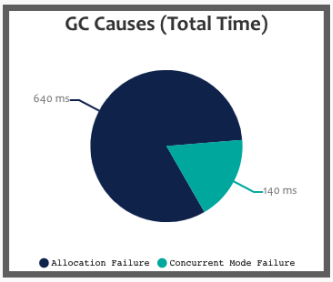
4) GC 原因

-Xmx512m -Xms512m

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	18	35.6 ms	170 ms	640 ms
Concurrent Mode Failure	3	46.7 ms	50.0 ms	140 ms

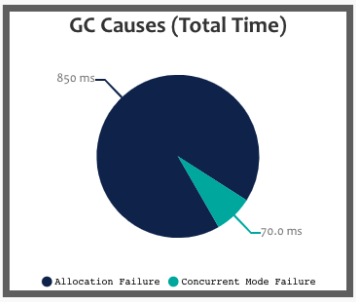


-Xmx1g -Xms1g

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
Allocation Failure	10	85.0 ms	420 ms	850 ms
Concurrent Mode Failure	1	70.0 ms	70.0 ms	70.0 ms



5) 内存分配速度

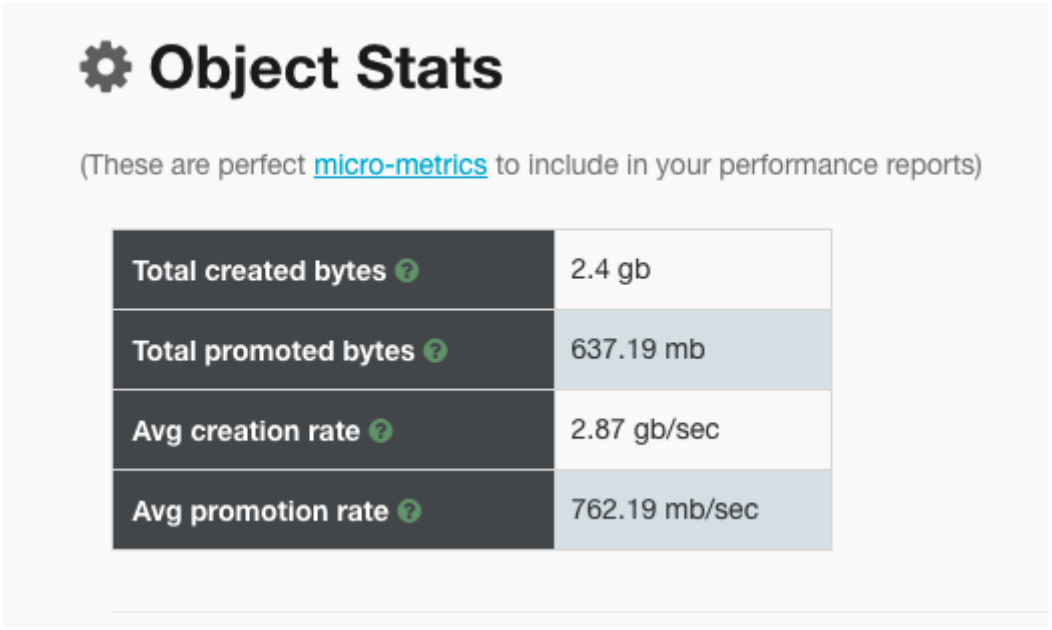
-Xmx512m -Xms512m

Object Stats

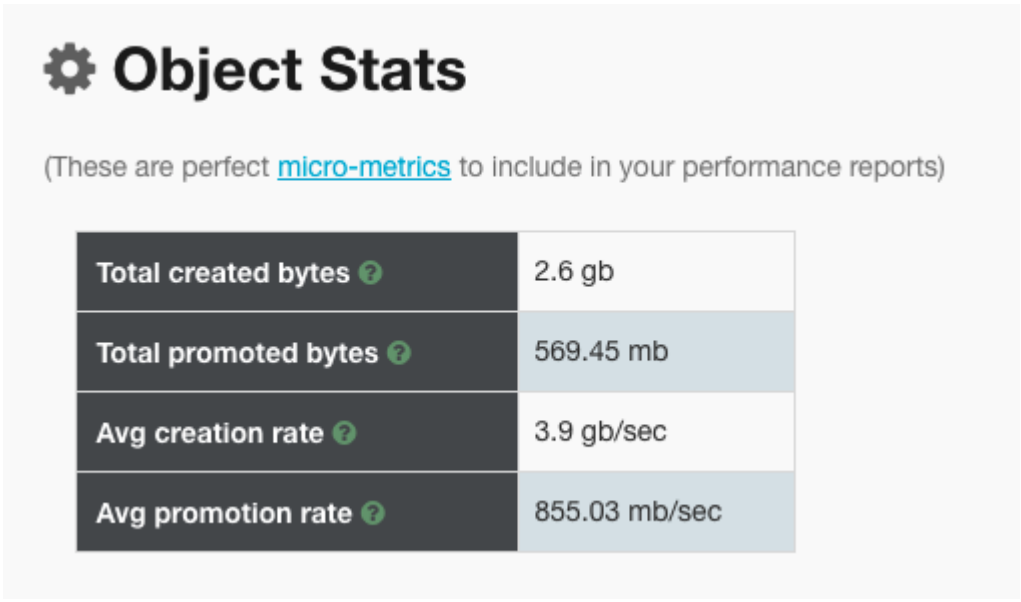
(These are perfect micro-metrics to include in your performance reports)

Total created bytes	1.85 gb
Total promoted bytes	461.79 mb
Avg creation rate	1.97 gb/sec
Avg promotion rate	491.27 mb/sec

-Xmx1g -Xms1g



-Xmx2g -Xms2g



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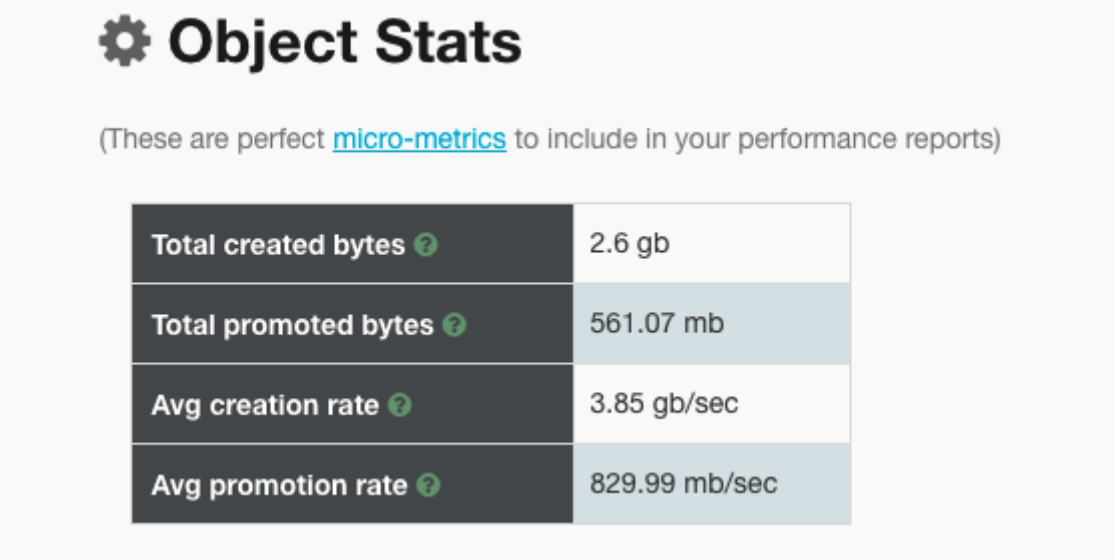
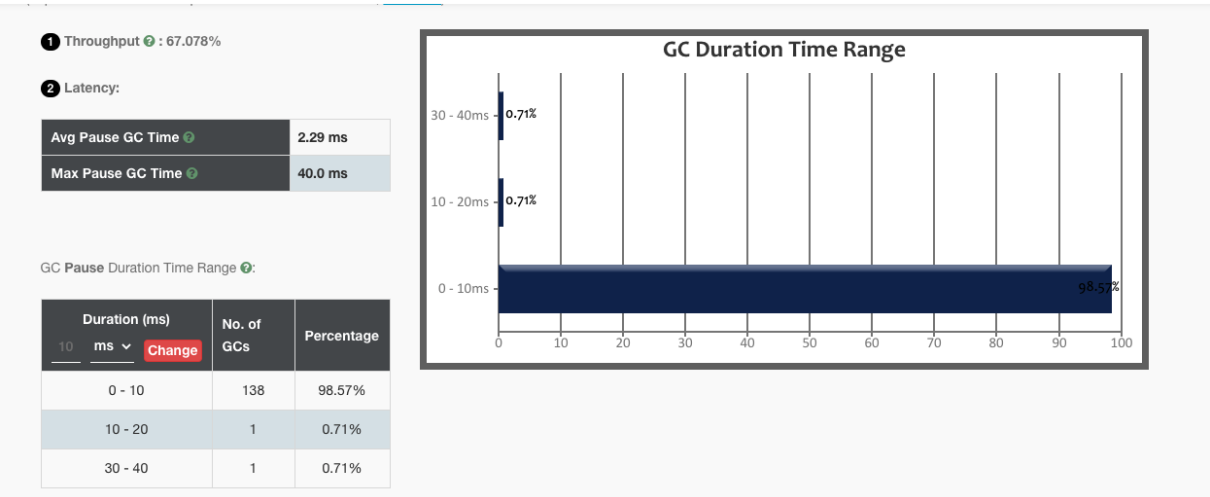


设置堆内存大小为 512m 时，发生了 6 次 CMS GC，其中 abortable preclean 阶段平均耗时 40 秒，final remark 阶段平均 0ms，这是因为 CMS GC。如果 abortale preclean 阶段时间太短，随后在 remark 时，新生代占用越大，则 remark 持续的时间（STW）越长。 在堆内存设置 2g 及 4g 情况下， 没有发生 Full GC。在分析 GC 原因时，发现在设置 512m、1g 堆内存情况下，发生了 Concurrent Mode Failure，这是 CMS 垃圾收集器的特有错误。在并行清理过程中，老年代的空间不足导致，可以理解成垃圾产生速度大于清理速度？。发生 Concurrent Mode Failure 后 CMS 垃圾收集器会从 CMS 退化成 Serial GC。

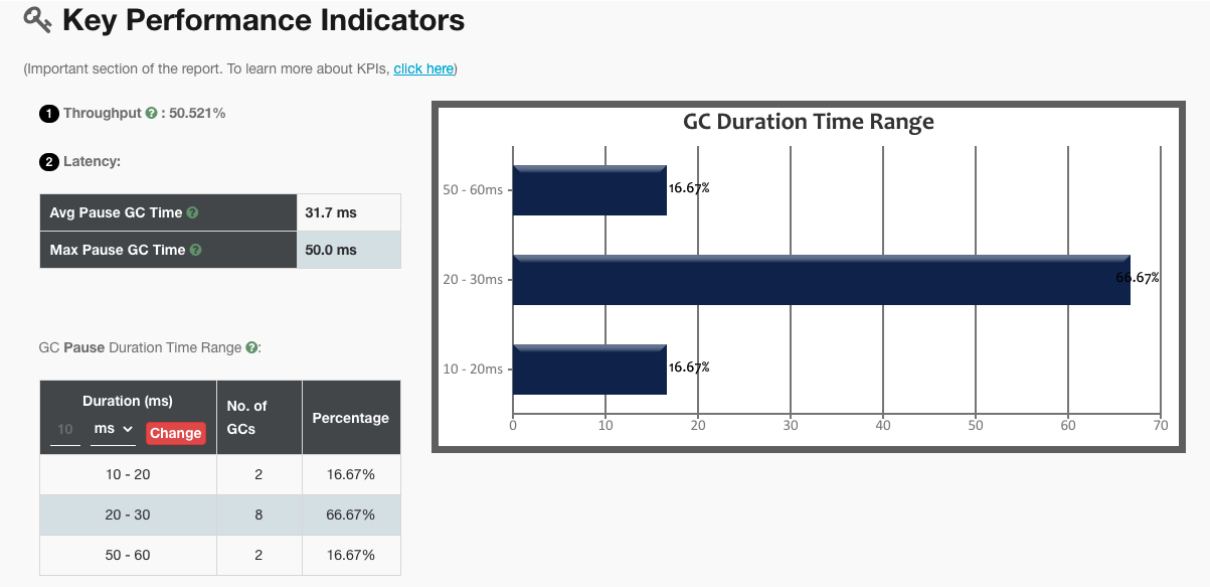
5. G1 GC 分析

1）GC 暂停时间



-Xmx512m -Xms512m 时，GC 暂停时间最优，平均 GC 暂停时间为 2.29ms，最长 GC

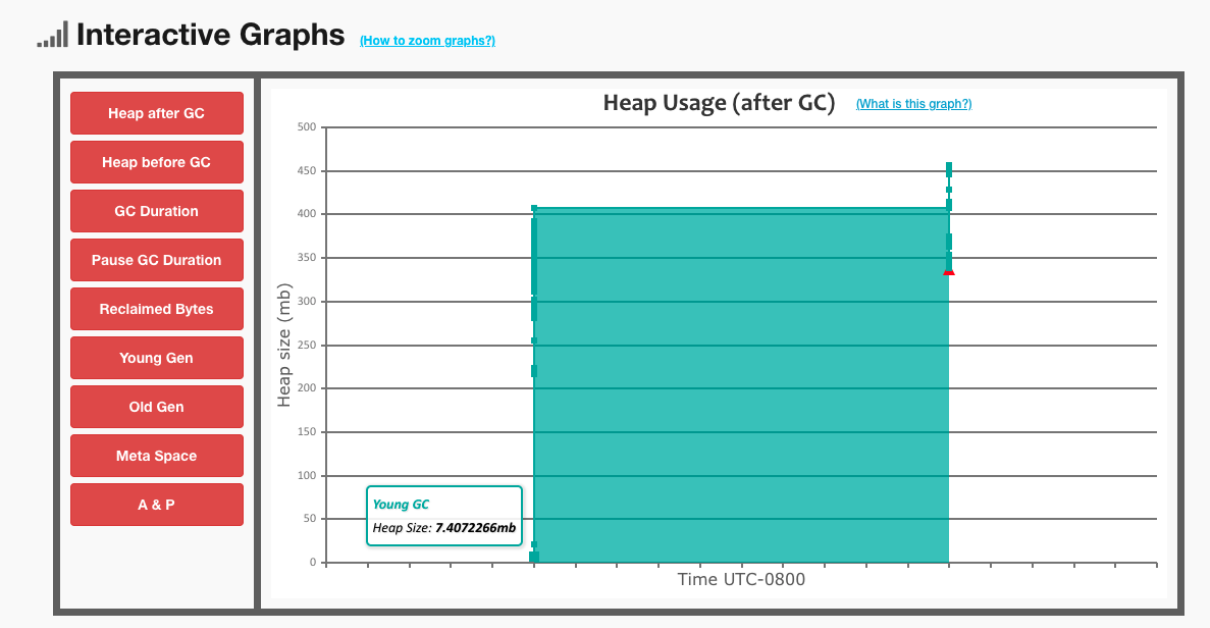
暂停时间为 40ms。0-10 时间段内占比较高。



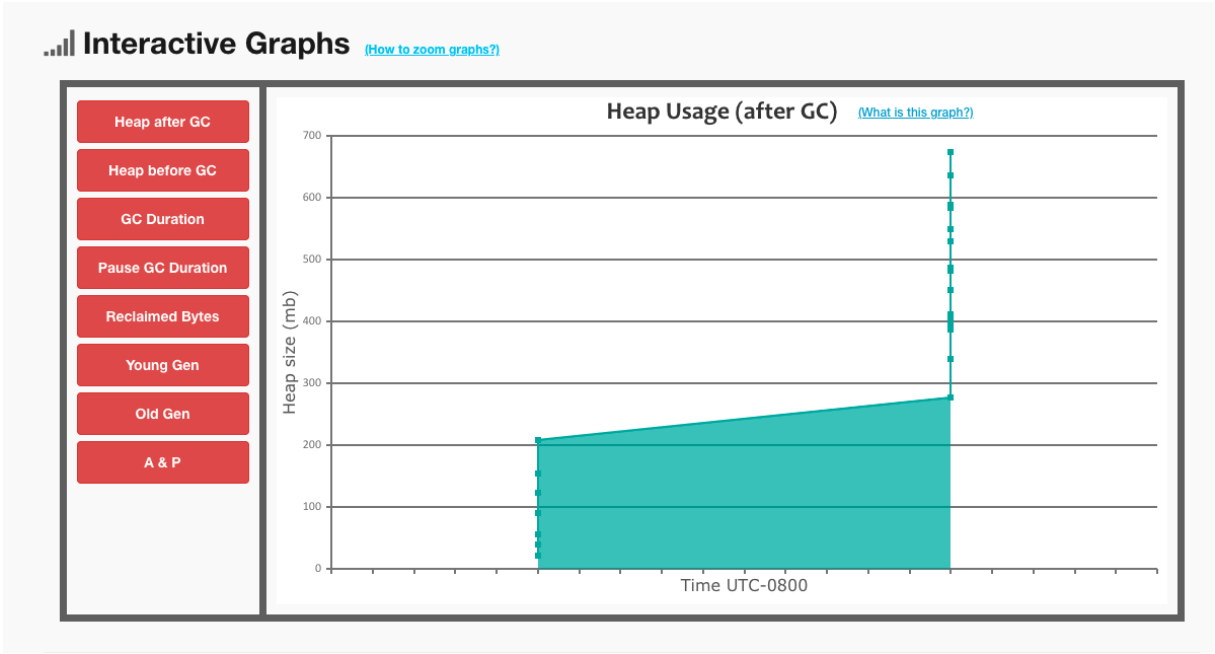
-Xmx4g -Xms4g 时，GC 暂停时间最长，平均 GC 暂停时间为 31.7ms，最长 GC 暂停时间为 50ms。20-30 时间段，占比较高。

2）堆内存使用情况

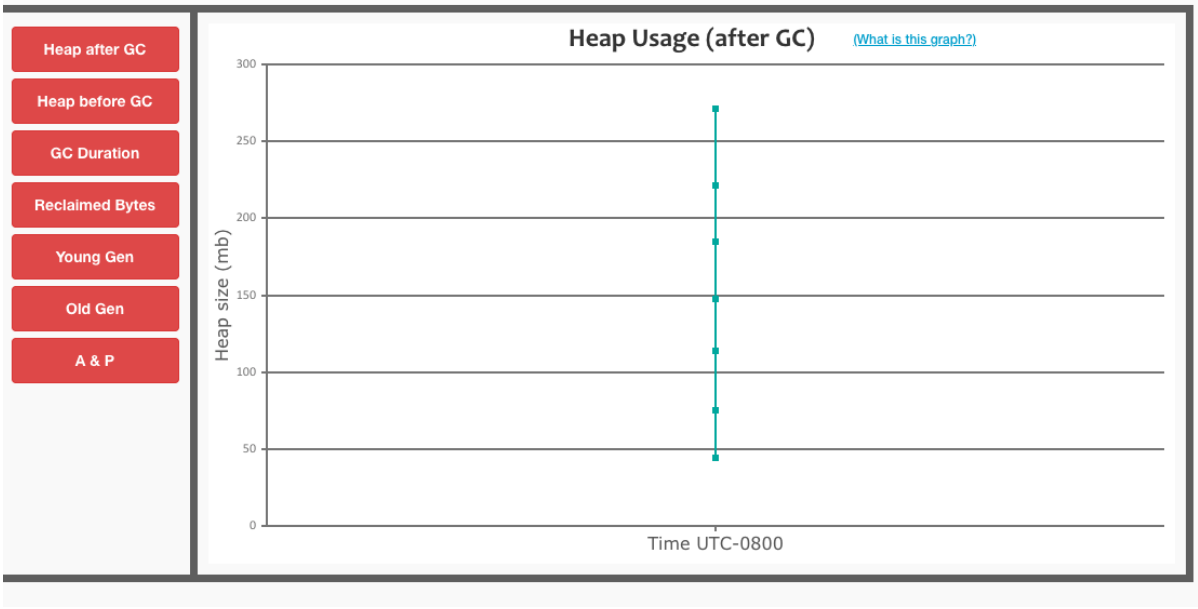
-Xmx512m -Xms512m



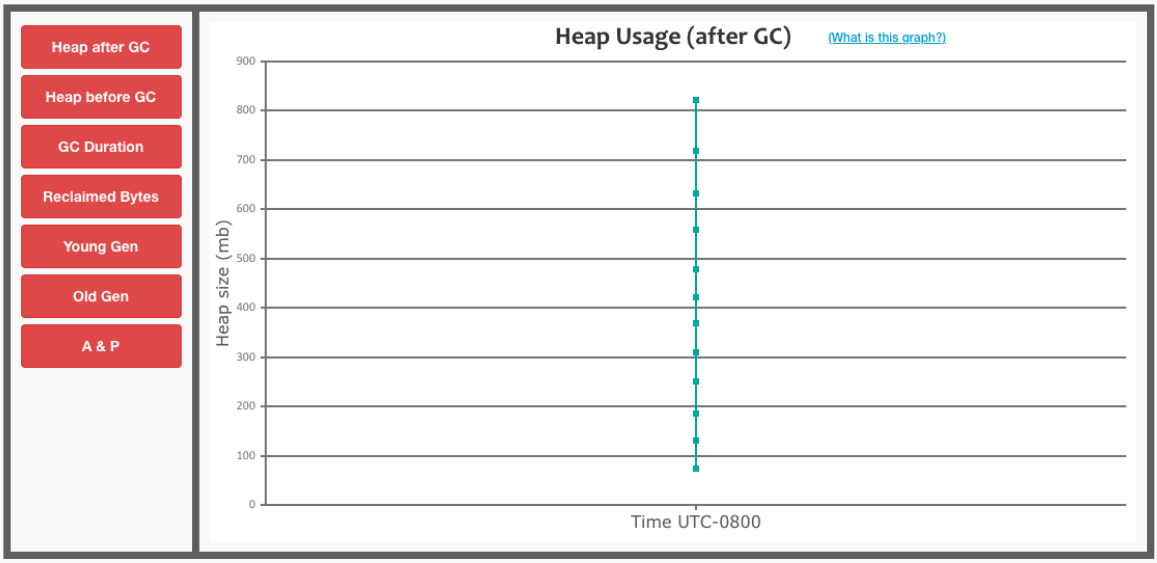
-Xmx1g -Xms1g



-Xmx2g -Xms2g



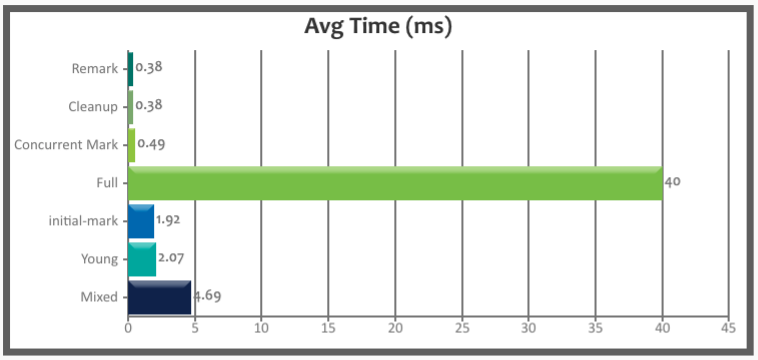
-Xmx4g -Xms4g

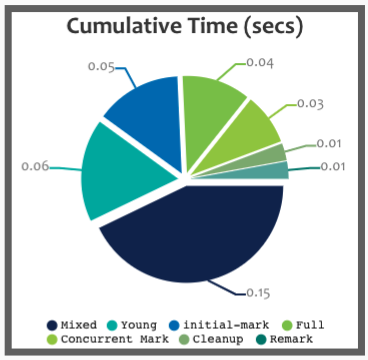


3) GC 情况统计

-Xmx512m -Xms512m

(One G1 GC event has multiple phases. This section provides detailed statistics of each G1 phases.)

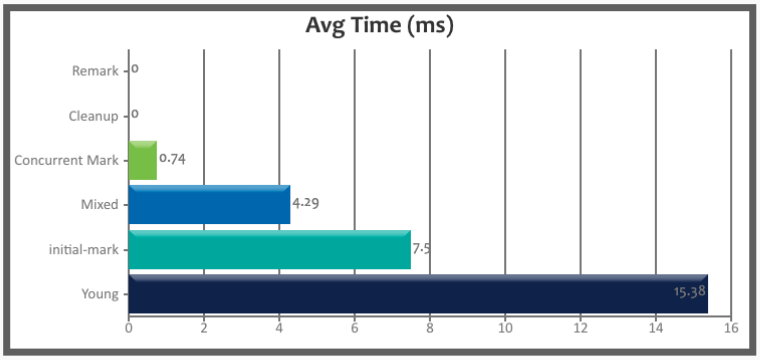


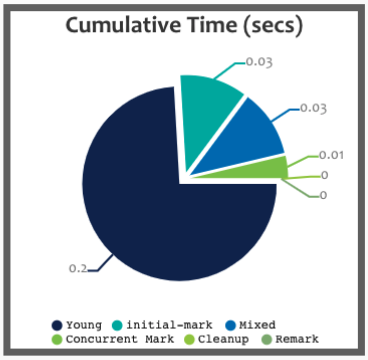


	Mixed	Young	initial-mark	Full	Concurrent Mark	Cleanup	Remark	Total
Count	32	29	26	1	52	26	26	192
Total GC Time	150 ms	60.0 ms	50.0 ms	40.0 ms	25.2 ms	10.0 ms	10.0 ms	345 ms
Avg GC Time	4.69 ms	2.07 ms	1.92 ms	40.0 ms	0.485 ms	0.385 ms	0.385 ms	1.80 ms
Avg Time std dev	4.99 ms	4.83 ms	3.94 ms	0	0.503 ms	1.92 ms	1.92 ms	4.57 ms
Min/Max Time	0 / 10.0 ms	0 / 20.0 ms	0 / 10.0 ms	0 / 40.0 ms	0 / 1.88 ms	0 / 10.0 ms	0 / 10.0 ms	0 / 40.0 ms
Avg Interval Time	22.0 ms	34.0 ms	28.0 ms	n/a	14.0 ms	28.0 ms	28.0 ms	24.0 ms

-Xmx1g -Xms1g

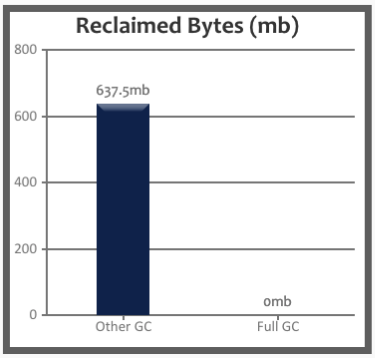
(One G1 GC event has multiple phases. This section provides detailed statistics of each G1 phases.)

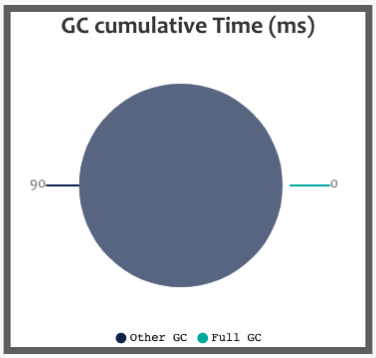


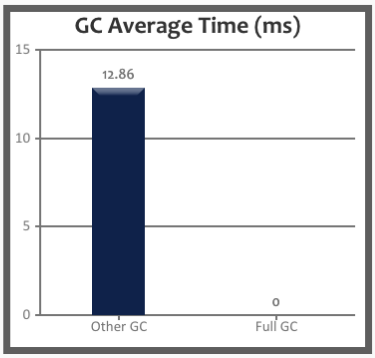


	Young	initial-mark	Mixed	Concurrent Mark	Cleanup	Remark	Total
Count	13	4	7	8	4	4	40
Total GC Time	200 ms	30.0 ms	30.0 ms	5.93 ms	0	0	266 ms
Avg GC Time	15.4 ms	7.50 ms	4.29 ms	0.741 ms	0	0	6.65 ms
Avg Time std dev	10.8 ms	13.0 ms	4.95 ms	0.868 ms	0	0	10.1 ms
Min/Max Time	0 / 40.0 ms	0 / 30.0 ms	0 / 10.0 ms	0 / 2.58 ms	0 / 0	0 / 0	0 / 40.0 ms
Avg Interval Time	75.0 ms	132 ms	63.0 ms	53.0 ms	124 ms	124 ms	82.0 ms

-Xmx2g -Xms2g







Total GC stats

Total GC count	7
Total reclaimed bytes	n/a
Total GC time	90.0 ms
Avg GC time	12.9 ms
GC avg time std dev	4.52 ms
GC min/max time	10.0 ms / 20.0 ms
GC Interval avg time	42.0 ms

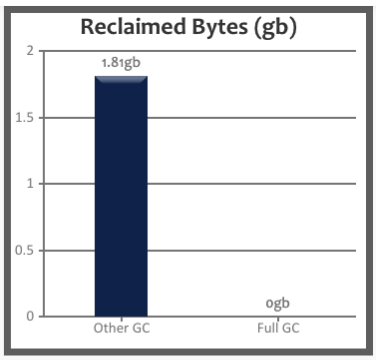
Other GC stats

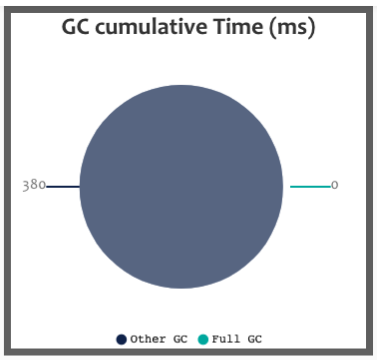
Other GC count	7
Other GC reclaimed	637.5 mb
Other GC total time	90.0 ms
Other GC avg time	12.9 ms
Other GC avg time std dev	4.52 ms
Other GC min/max time	10.0 ms / 20.0 ms
Other GC Interval avg	42.0 ms

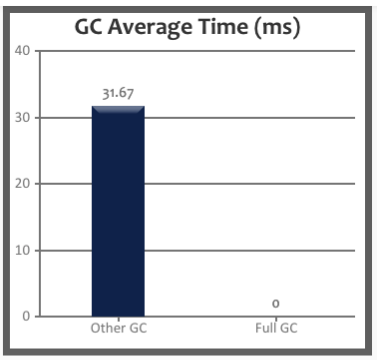
Full GC stats

Full GC Count	0
Full GC reclaimed	n/a
Full GC total time	n/a
Full GC avg time	n/a
Full GC avg time std dev	n/a
Full GC min/max time	n/a
Full GC Interval avg	n/a

-Xmx4g -Xms4g







Total GC stats

Total GC count	12
Total reclaimed bytes	n/a
Total GC time	380 ms
Avg GC time	31.7 ms
GC avg time std dev	8.98 ms
GC min/max time	20.0 ms / 50.0 ms
GC Interval avg time	69.0 ms

Other GC stats

Other GC count	12
Other GC reclaimed	1.81 gb
Other GC total time	380 ms
Other GC avg time	31.7 ms
Other GC avg time std dev	8.98 ms
Other GC min/max time	20.0 ms / 50.0 ms
Other GC Interval avg	69.0 ms

Full GC stats

Full GC Count	0
Full GC reclaimed	n/a
Full GC total time	n/a
Full GC avg time	n/a
Full GC avg time std dev	n/a
Full GC min/max time	n/a
Full GC Interval avg	n/a

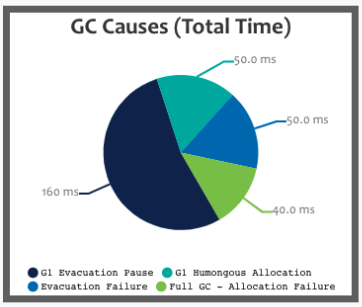
4) GC 原因

-Xmx512m -Xms512m

GC Causes

(What events caused GCs & how much time they consumed?)

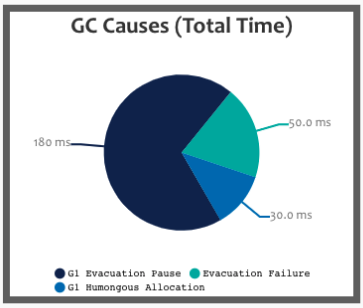
Cause	Count	Avg Time	Max Time	Total Time
G1 Evacuation Pause	53	3.02 ms	10.0 ms	160 ms
G1 Humongous Allocation	26	1.92 ms	10.0 ms	50.0 ms
Evacuation Failure	8	6.25 ms	20.0 ms	50.0 ms
Full GC - Allocation Failure	1	40.0 ms	40.0 ms	40.0 ms



-Xmx1g -Xms1g

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
G1 Evacuation Pause	18	10.0 ms	30.0 ms	180 ms
Evacuation Failure	2	25.0 ms	40.0 ms	50.0 ms
G1 Humongous Allocation	4	7.50 ms	30.0 ms	30.0 ms

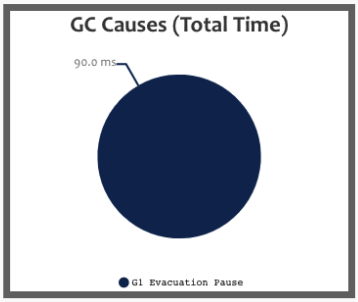


-Xmx2g -Xms2g

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
G1 Evacuation Pause	7	12.9 ms	20.0 ms	90.0 ms

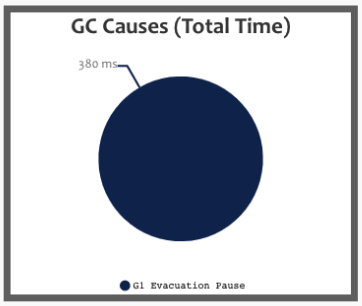


-Xmx4g -Xms4g

GC Causes

(What events caused GCs & how much time they consumed?)

Cause	Count	Avg Time	Max Time	Total Time
G1 Evacuation Pause	12	31.7 ms	50.0 ms	380 ms



5) 内存分配速度

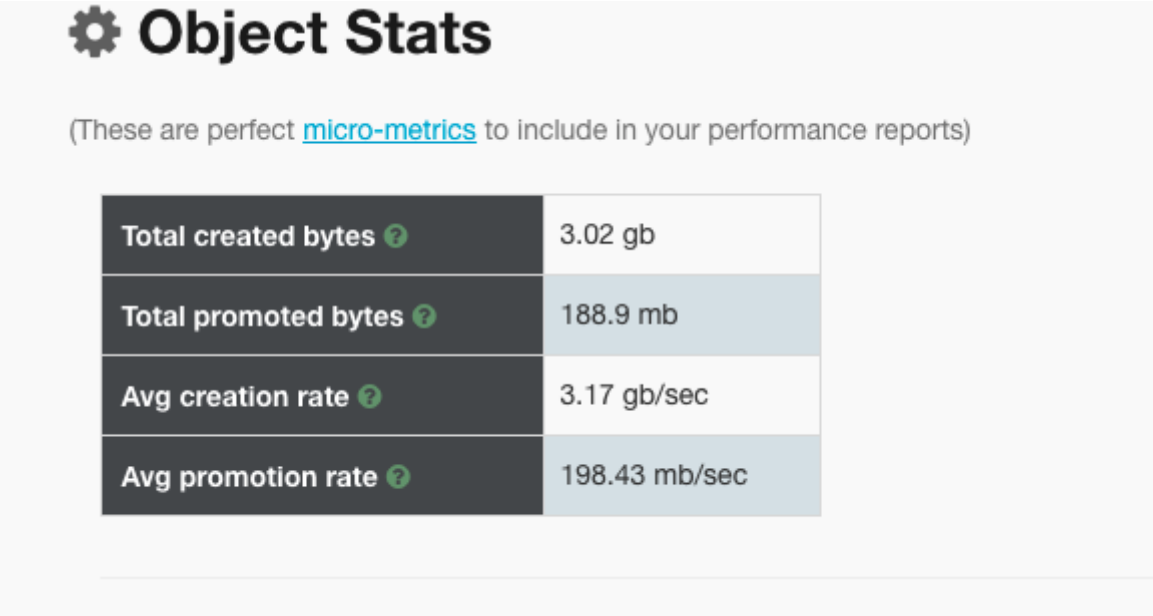
-Xmx512m -Xms512m

Object Stats

(These are perfect micro-metrics to include in your performance reports)

Total created bytes	2.81 gb
Total promoted bytes	411.1 mb
Avg creation rate	2.89 gb/sec
Avg promotion rate	422.94 mb/sec

-Xmx1g -Xms1g



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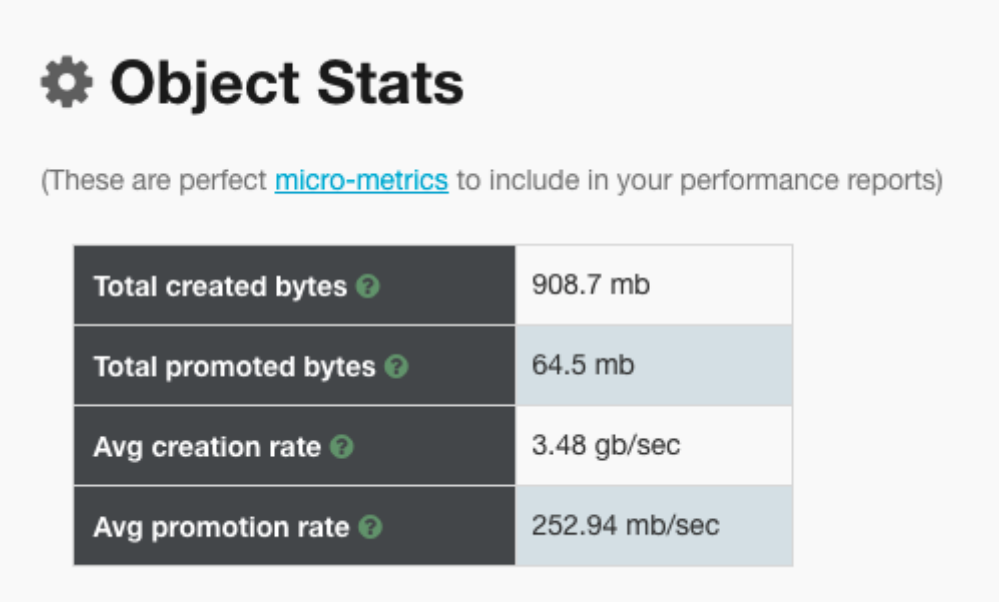
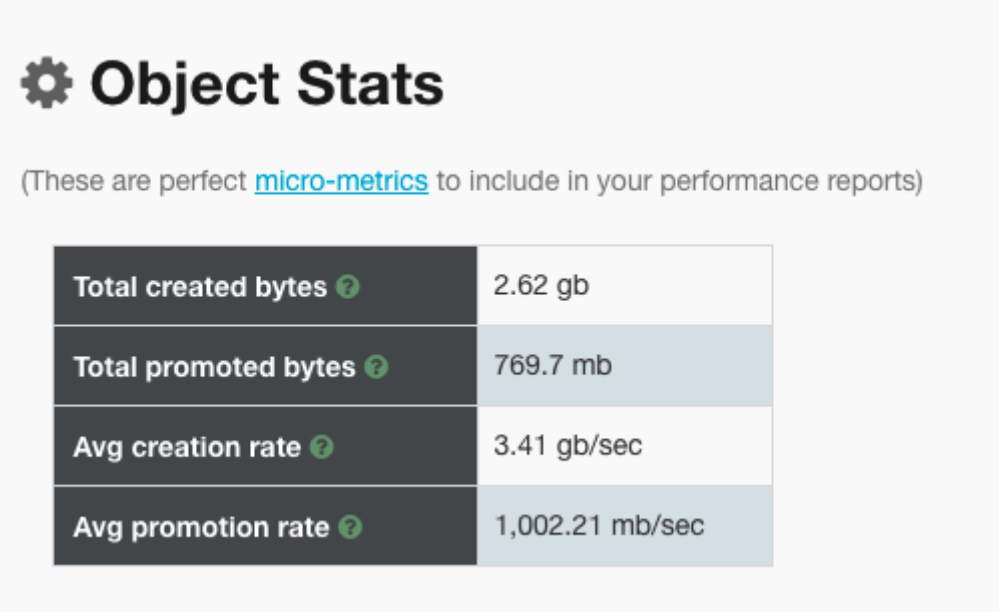


-Xmx4g -Xms4g



设置堆内存大小为 512m 时，发生了 29 次 Young GC，1 次 Full GC，平均 Young GC 的时间为 2.07ms，Full GC 40ms。频繁发生 Young GC。在设置堆内存为 1g 时，发生 13 次 Young GC,8 次并发标记，7 次 mixed，并未发生清理操作。堆内存 512m 时，发生了 53 次 Evauation pause，将存活对象拷贝到另一个区域；26 次 Humongous Allocation，频繁产生大型对象占用空间；8 次 Evacuation Failure，占用空间达到堆内存设置的最大值，堆不能扩展导致。Full GC-Allocation Failure，短时间内大量新对象被创建，Young GC 来不及回收，晋升至老年代导致老年代空间不足够容纳新对象导致 Full GC。

6. 总结

根据 gc 暂停时间来看，在设置堆内存为 512m 时，G1 GC 最短。平均暂停时间为 2.29ms；而 Serial GC 最长，平均暂停时间为 32.9ms，原因在于串行 GC 是单线程的垃圾收集器，在处理过程中，会停止所有的线程用于垃圾回收触发 STW，因此暂停时间较长。在比较同一种垃圾处理不同堆内存设置中，设置堆内存为 4g 的 gc 暂停时间相对较长，比较 4 种垃圾回收，发现在堆内存设置为 4g 时，也存在 G1GC 暂停时间最短，Serial GC 暂停时间较长的现象。