# Tweaking Jira's Garbage Collection flags for use with GCViewer

The takeaway from this article is that, if you run Jira Server, there is a config tweak you really ought to make, to allow the use of GCViewer to debug any future garbage collection problems:

For Jira, edit `/opt/atlassian/jira/bin/set-gc-params.sh` and add make this change:

```
diff --git a/bin/set-gc-params.sh b/bin/set-gc-params.sh
--- a/bin/set-gc-params.sh
+++ b/bin/set-gc-params.sh
@@ -6,7 +6,7 @@
 then
     # In Java 9, GC logging has been re-implemented using the Unified GC logging framework.
     # See http://openjdk.java.net/jeps/158 or https://docs.oracle.com/javase/10/jrockit-hotspot/logging.htm
-    GC_JVM_PARAMETERS="-Xlog:gc*:file=$LOGBASEABS/logs/atlassian-jira-gc-%t.log:time,uptime:filecount=5,
filesize=20M ${GC_JVM_PARAMETERS}"
+    GC_JVM_PARAMETERS="-Xlog:gc*:file=$LOGBASEABS/logs/atlassian-jira-gc-%t.log:time,uptime,tags,level:
filecount=5,filesize=20M ${GC_JVM_PARAMETERS}"
     GC_JVM_PARAMETERS="${GC_JVM_PARAMETERS} ${JVM_GC_ARGS}"
 else
     # Set the JVM arguments used to start Jira. For a description of the options, see
```

## What's this all about?

Jira is written in Java, which is a "garbage-collected" language. This means that Java programmers don't need to worry about de-allocating memory; the Java virtual machine (JVM) periodically "garbage collects" any memory that is unused.

Garbage collection (GC) happens all the time in a running JVM, and typically takes only milliseconds. However if your JVM is under memory pressure, a full GC can't actually free up that much memory, and soon after another GC is needed, and another.. and you get a situation where the JVM is spending more time GC'ing than doing anything useful. This is called **GC thrashing**.

If you're lucky you'll see an `OutOfMemoryError` in your `/opt/atlassian/jira/logs/catalina.out` log file, making the diagnosis easy. But sometimes Jira will just be really slow, high CPU usage, and thread dumps showing a variety of threads doing normal CPU-bound things. but not quite enough to trigger an OutOfMemoryError) on garbage collector threads trying to clear up memory.

The best way to diagnose GC thrashing, or any "what the hell is Jira so busy with?" situation, is to use `top` (or `htop` or `atop` ) with threads enabled, so you can see which Java thread(s) are the CPU consumers. I like `atop` for its ability to rewind and view past states. Here is `atop` after pressing 'y' to enable threads:

```
PRC | sys    2m16s  | user   1h51m |  #proc  67367 |  #tslpi  1692 | #tslpu     0  | #zombie    0 |  #exit >66873 |
CPU | sys      25%  | user   1122% |  irq       1% |  idle    390% | wait     61%  | curf 3.60GHz |  curscal   ?% |
CPL | avg1   16.12  | avg5   14.24 |  avg15  13.50 |  csw 15111234 | intr 9917839  |              |  numcpu    16 |
MEM | tot    30.6G  | free  520.0M |  cache   6.3G |  buff   28.6M | slab    3.1G  | vmbal   0.0M |  hptot   0.0M |
SWP | tot    10.0G  | free    7.9G |               |               |               | vmcom  27.2G |  vmlim  25.3G |
PAG | scan  123088  | steal  72739 |  stall      0 |               |               | swin     142 |  swout   2734 |
NET | transport     | tcpi  911467 |  tcpo  950150 |  udpi   26776 | udpo   26776  | tcpao   1033 |  tcppo   5831 |
NET | network       | ipi   939502 |  ipo   930570 |  ipfrw      0 | deliv 939502  | icmpi   1258 |  icmpo      1 |
NET | lo      ----  | pcki  786176 |  pcko  786176 |  sp    0 Mbps | si 7473 Kbps  | so 7473 Kbps |  erro       0 |
NET | ens5    ----  | pcki  158716 |  pcko  193202 |  sp    0 Mbps | si  862 Kbps  | so 2143 Kbps |  erro       0 |
Only 66873 exited processes handled -- 125664 skipped!
  PID    TID CID          SYSCPU USRCPU  VGROW  RGROW  RDDSK  WRDSK RUID     ST EXC  THR S CPUNR  CPU CMD     1/1677
23586      - host-------- 33.01s  1h48m 82476K -55.4M 918.1M   2.4G jira     --   -  432 S    12 1092% java
23586  23586 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S    12   0% java
23586  23702 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S     1   0% java
23586  23709 host-------- 1.38s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R     9  79% ParGC Thread#0
23586  23720 host-------- 0.88s 93.58s 82476K -55.4M   104K   322K jira     --   -    1 S     3  16% VM Thread
23586  23724 host-------- 0.02s  0.12s 82476K -55.4M     0K     0K jira     --   -    1 S    11   0% Reference Hand
23586  23725 host-------- 0.01s  0.13s 82476K -55.4M     0K     0K jira     --   -    1 S     3   0% Finalizer
23586  23734 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S    14   0% Signal Dispatc
23586  23735 host-------- 0.03s  2.66s 82476K -55.4M     4K     0K jira     --   -    1 S     5   0% C2 CompilerThr
23586  23736 host-------- 0.01s  0.13s 82476K -55.4M     0K     4K jira     --   -    1 S     5   0% C1 CompilerThr
23586  23737 host-------- 0.03s  2.15s 82476K -55.4M     0K     0K jira     --   -    1 S    14   0% Sweeper thread
23586  23764 host-------- 0.00s  0.01s 82476K -55.4M     0K     0K jira     --   -    1 S     0   0% Common-Cleaner
23586  23801 host-------- 0.08s  0.46s 82476K -55.4M   212K 40243K jira     --   -    1 S    15   0% JFR Recorder T
23586  23881 host-------- 0.10s  0.06s 82476K -55.4M     0K    20K jira     --   -    1 S     0   0% JFR Periodic T
23586  23886 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S    12   0% JFR Recording
23586  23907 host-------- 0.18s  0.54s 82476K -55.4M     0K     0K jira     --   -    1 S     9   0% java
23586  23908 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S     1   0% Service Thread
23586  23909 host-------- 0.14s  0.08s 82476K -55.4M     0K   152K jira     --   -    1 S    14   0% VM Periodic Ta
23586  23920 host-------- 0.01s  0.01s 82476K -55.4M    28K   124K jira     --   -    1 S     9   0% AsyncFileHandl
23586  24107 host-------- 0.01s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S     7   0% Abandoned conn
23586  24147 host-------- 0.35s  0.35s 82476K -55.4M     0K     0K jira     --   -    1 S     5   0% NioBlockingSel
23586  24149 host-------- 1.20s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R    12  79% ParGC Thread#1
23586  24150 host-------- 1.14s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R    15  79% ParGC Thread#2
23586  24151 host-------- 1.20s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R     1  79% ParGC Thread#3
23586  24152 host-------- 1.24s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R    10  79% ParGC Thread#4
23586  24153 host-------- 1.03s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R     8  79% ParGC Thread#5
23586  24154 host-------- 1.11s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R     2  79% ParGC Thread#6
23586  24155 host-------- 1.14s  7m53s 82476K -55.4M     4K     0K jira     --   -    1 R     0  79% ParGC Thread#7
23586  24469 host-------- 1.25s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R     6  79% ParGC Thread#8
23586  24470 host-------- 1.08s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R     4  79% ParGC Thread#9
23586  24471 host-------- 1.07s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R     7  79% ParGC Thread#1
23586  24818 host-------- 1.27s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R    11  79% ParGC Thread#1
23586  24819 host-------- 1.14s  7m53s 82476K -55.4M     0K     0K jira     --   -    1 R     3  79% ParGC Thread#1
23586  25829 host-------- 0.05s  0.20s 82476K -55.4M   332K  3174K jira     --   -    1 S     5   0% ContainerBackg
23586  25831 host-------- 0.00s  0.01s 82476K -55.4M     0K     0K jira     --   -    1 S    12   0% NioBlockingSel
23586  25833 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S     6   0% http-nio-127.0
23586  25834 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S    14   0% http-nio-127.0
23586  25835 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S     4   0% http-nio-127.0
23586  25836 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S     7   0% http-nio-127.0
23586  25837 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S     0   0% http-nio-127.0
23586  25839 host-------- 0.00s  0.00s 82476K -55.4M     0K     0K jira     --   -    1 S     4   0% http-nio-127.0
```

See in the CPU column: Jira is consuming all CPU (1092%), and specifically the only threads active (79% each) are **ParGC Thread** threads.

## GC logs

Out the box, Jira (8.7.1+) is configured with these GC configuration parameters:

```
# in bin/setenv.sh
JVM_GC_ARGS="-XX:+ExplicitGCInvokesConcurrent"
# in bin/set-gc-params.sh
GC_JVM_PARAMETERS="-Xlog:gc*:file=$LOGBASEABS/logs/atlassian-jira-gc-%t.log:time,uptime:filecount=5,
filesize=20M $  {GC_JVM_PARAMETERS}"
GC_JVM_PARAMETERS="${GC_JVM_PARAMETERS} ${JVM_GC_ARGS}"
```

If you are using Java 9 or above, this means the G1GC algorithm is in use (see Disruptive Changes to GC Logging in Java 9). Earlier versions of Jira used the older Parallel GC (see JRASERVER-64331 - Ship Jira with G1GC enabled by default GATHERING INTEREST ), and look like this:

```
    GC_JVM_PARAMETERS="-Xlog:gc*:file=$LOGBASEABS/logs/atlassian-jira-gc-%t.log:time,uptime:filecount=5,
filesize=20M ${GC_JVM_PARAMETERS}"
    GC_JVM_PARAMETERS="-XX:+UseParallelGC ${GC_JVM_PARAMETERS}"
```

Either way, you should have a log file, `/opt/atlassian/jira/logs/atlassian-jira-log-gc-*.log`. GC logs looking something like this:

```
[2020-09-22T03:34:05.289-0700][2465737.513s] GC(355175) Pause Full (Ergonomics) 5020M->4521M(5587M) 3608.541ms
[2020-09-22T03:34:05.289-0700][2465737.513s] GC(355175) User=41.39s Sys=0.00s Real=3.60s
[2020-09-22T03:34:05.524-0700][2465737.748s] GC(355176) Pause Full (Ergonomics)
[2020-09-22T03:34:05.524-0700][2465737.748s] GC(355176) Marking Phase
[2020-09-22T03:34:06.432-0700][2465738.656s] GC(355176) Marking Phase 908.653ms
[2020-09-22T03:34:06.432-0700][2465738.656s] GC(355176) Summary Phase
[2020-09-22T03:34:06.432-0700][2465738.657s] GC(355176) Summary Phase 0.074ms
[2020-09-22T03:34:06.432-0700][2465738.657s] GC(355176) Adjust Roots
[2020-09-22T03:34:06.592-0700][2465738.816s] GC(355176) Adjust Roots 159.736ms
[2020-09-22T03:34:06.592-0700][2465738.816s] GC(355176) Compaction Phase
[2020-09-22T03:34:09.213-0700][2465741.437s] GC(355176) Compaction Phase 2620.355ms
[2020-09-22T03:34:09.213-0700][2465741.437s] GC(355176) Post Compact
[2020-09-22T03:34:09.238-0700][2465741.462s] GC(355176) Post Compact 25.488ms
[2020-09-22T03:34:09.238-0700][2465741.462s] GC(355176) PSYoungGen: 957440K->451409K(1527296K)
[2020-09-22T03:34:09.238-0700][2465741.462s] GC(355176) ParOldGen: 4194303K->4194162K(4194304K)
[2020-09-22T03:34:09.238-0700][2465741.462s] GC(355176) Metaspace: 759906K->759906K(1824768K)
[2020-09-22T03:34:09.238-0700][2465741.462s] GC(355176) Pause Full (Ergonomics) 5030M->4536M(5587M) 3714.746ms
[2020-09-22T03:34:09.238-0700][2465741.462s] GC(355176) User=42.65s Sys=0.10s Real=3.71s
[2020-09-22T03:34:09.387-0700][2465741.611s] GC(355177) Pause Full (Ergonomics)
[2020-09-22T03:34:09.387-0700][2465741.611s] GC(355177) Marking Phase
[2020-09-22T03:34:10.306-0700][2465742.531s] GC(355177) Marking Phase 919.544ms
[2020-09-22T03:34:10.306-0700][2465742.531s] GC(355177) Summary Phase
[2020-09-22T03:34:10.307-0700][2465742.531s] GC(355177) Summary Phase 0.078ms
[2020-09-22T03:34:10.307-0700][2465742.531s] GC(355177) Adjust Roots
[2020-09-22T03:34:10.470-0700][2465742.694s] GC(355177) Adjust Roots 163.227ms
[2020-09-22T03:34:10.470-0700][2465742.694s] GC(355177) Compaction Phase
[2020-09-22T03:34:13.473-0700][2465745.698s] GC(355177) Compaction Phase 3003.617ms
[2020-09-22T03:34:13.474-0700][2465745.698s] GC(355177) Post Compact
[2020-09-22T03:34:13.499-0700][2465745.723s] GC(355177) Post Compact 25.643ms
[2020-09-22T03:34:13.499-0700][2465745.723s] GC(355177) PSYoungGen: 957440K->512920K(1527296K)
[2020-09-22T03:34:13.499-0700][2465745.723s] GC(355177) ParOldGen: 4194162K->4194126K(4194304K)
[2020-09-22T03:34:13.499-0700][2465745.723s] GC(355177) Metaspace: 759906K->759906K(1824768K)
[2020-09-22T03:34:13.499-0700][2465745.724s] GC(355177) Pause Full (Ergonomics) 5030M->4596M(5587M) 4112.550ms
[2020-09-22T03:34:13.499-0700][2465745.724s] GC(355177) User=47.24s Sys=0.00s Real=4.11s
[2020-09-22T03:34:13.503-0700][2465745.727s] GC(355178) Pause Full (Ergonomics)
[2020-09-22T03:34:13.503-0700][2465745.727s] GC(355178) Marking Phase
[2020-09-22T03:34:14.417-0700][2465746.641s] GC(355178) Marking Phase 914.147ms
[2020-09-22T03:34:14.417-0700][2465746.641s] GC(355178) Summary Phase
[2020-09-22T03:34:14.417-0700][2465746.641s] GC(355178) Summary Phase 0.066ms
[2020-09-22T03:34:14.417-0700][2465746.641s] GC(355178) Adjust Roots
[2020-09-22T03:34:14.555-0700][2465746.779s] GC(355178) Adjust Roots 138.314ms
[2020-09-22T03:34:14.555-0700][2465746.779s] GC(355178) Compaction Phase
[2020-09-22T03:34:17.136-0700][2465749.361s] GC(355178) Compaction Phase 2581.276ms
[2020-09-22T03:34:17.137-0700][2465749.361s] GC(355178) Post Compact
[2020-09-22T03:34:17.161-0700][2465749.385s] GC(355178) Post Compact 24.319ms
[2020-09-22T03:34:17.161-0700][2465749.385s] GC(355178) PSYoungGen: 513664K->513419K(1527296K)
[2020-09-22T03:34:17.161-0700][2465749.385s] GC(355178) ParOldGen: 4194126K->4194120K(4194304K)
[2020-09-22T03:34:17.161-0700][2465749.385s] GC(355178) Metaspace: 759906K->759906K(1824768K)
[2020-09-22T03:34:17.161-0700][2465749.385s] GC(355178) Pause Full (Ergonomics) 4597M->4597M(5587M) 3658.596ms
[2020-09-22T03:34:17.161-0700][2465749.385s] GC(355178) User=42.50s Sys=0.01s Real=3.66s
[2020-09-22T03:34:17.318-0700][2465749.542s] GC(355179) Pause Full (Ergonomics)
[2020-09-22T03:34:17.318-0700][2465749.542s] GC(355179) Marking Phase
[2020-09-22T03:34:18.222-0700][2465750.446s] GC(355179) Marking Phase 903.470ms
[2020-09-22T03:34:18.222-0700][2465750.446s] GC(355179) Summary Phase
[2020-09-22T03:34:18.222-0700][2465750.446s] GC(355179) Summary Phase 0.074ms
[2020-09-22T03:34:18.222-0700][2465750.446s] GC(355179) Adjust Roots
```

The sample log above is from a thrashing server using the older ParallelGC algorithm. The lines to note are marked **Pause Full**. e.g.:

```
[2020-09-22T03:34:09.238-0700][2465741.462s] GC(355176) Pause Full (Ergonomics) 5030M->4536M(5587M) 3714.746ms
.....
[2020-09-22T03:34:13.499-0700][2465745.724s] GC(355177) Pause Full (Ergonomics) 5030M->4596M(5587M) 4112.550ms
[2020-09-22T03:34:13.499-0700][2465745.724s] GC(355177) User=47.24s Sys=0.00s Real=4.11s
```

By subtracting the timestamps we see a 4.26s interval between full GCs (2465745.724 - 2465741.462), of which the GC occcupied 4.11s. This is what thrashing looks like.

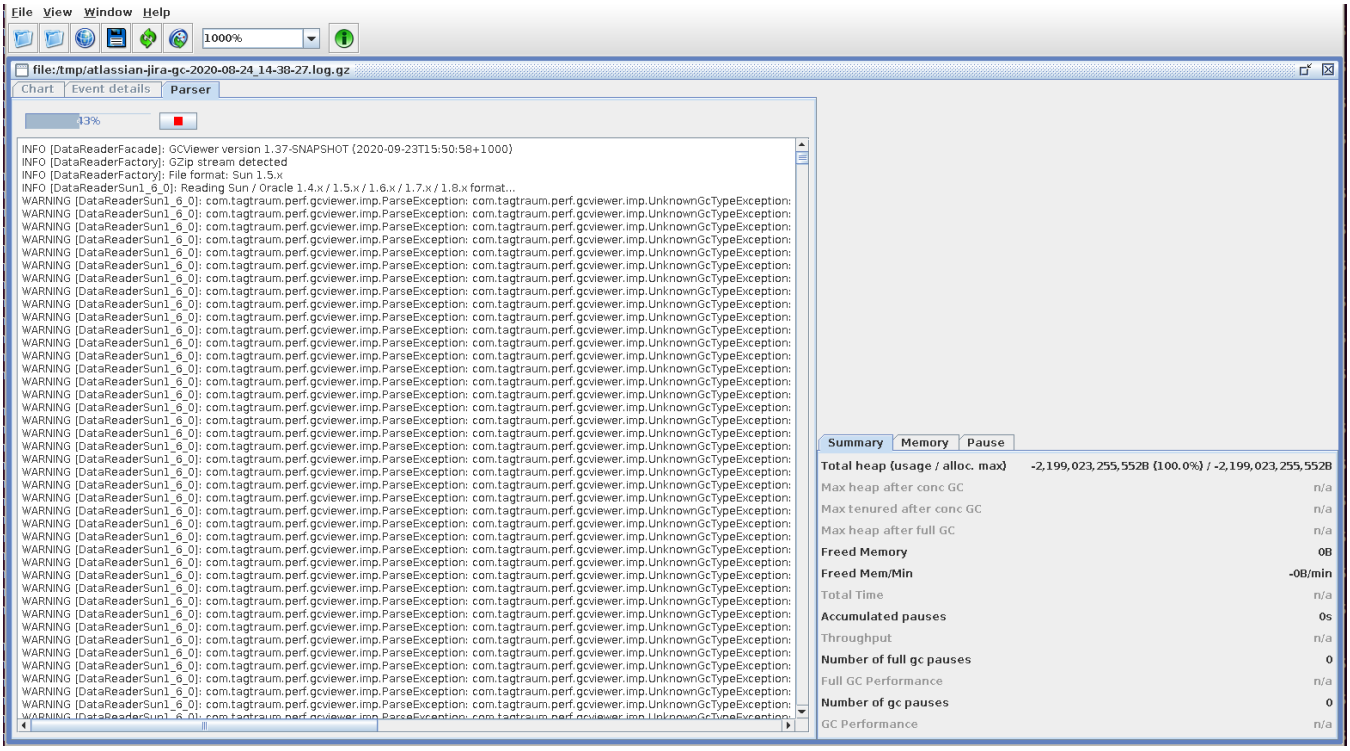
Interpreting GC log files is exceptionally tedious - finding relevant lines, doing timestamp math, etc. If you did want to further analyze this GC log file, what tools could you use?

## GCViewer

My tool of choice is GCViewer, because it has been around forever and does the job.

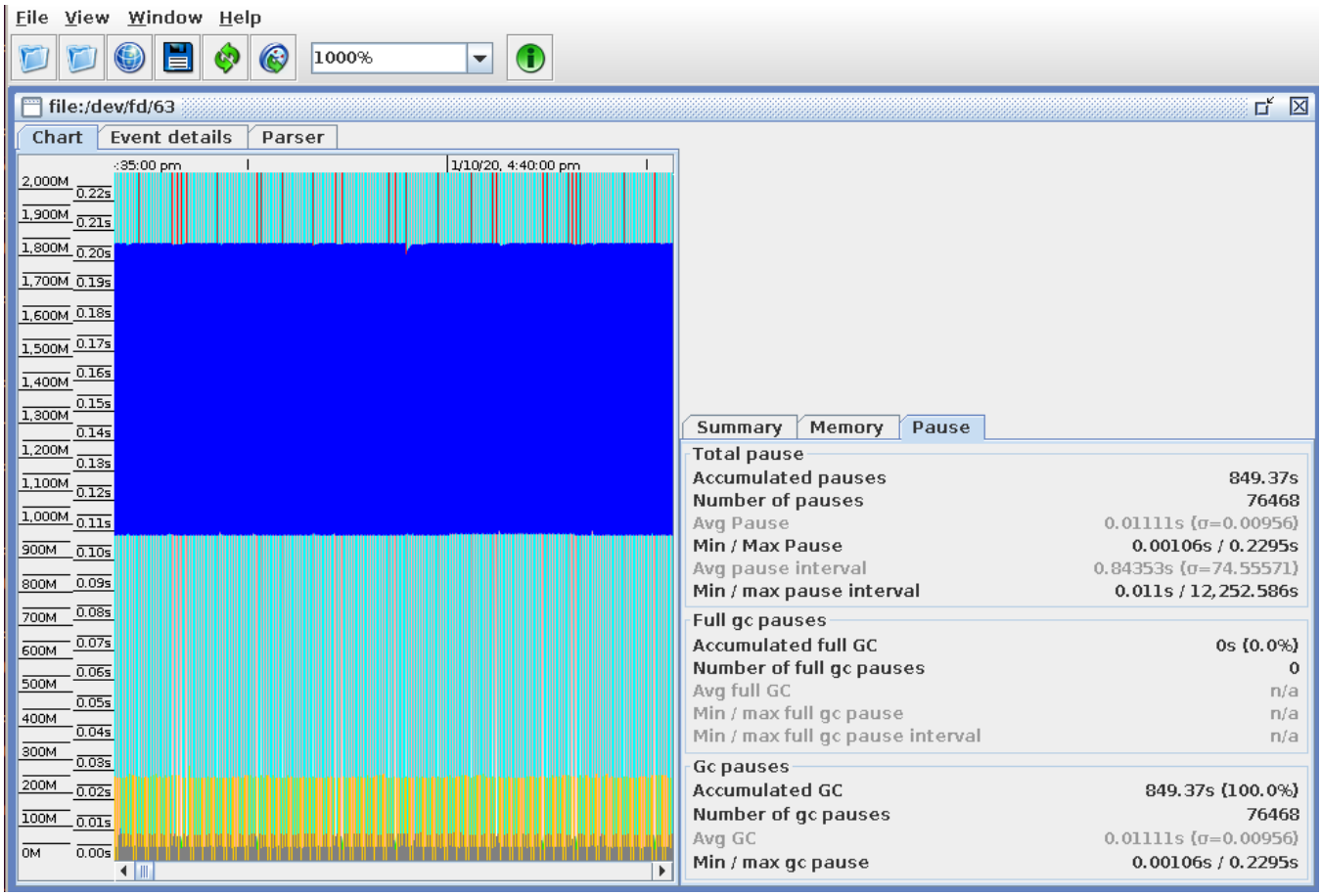
The problem alluded to in the introduction is that GCViewer cannot read the default format of GC logs generated by Jira and Confluence, when using Java 9+. You'll just get an error for each line parsed:

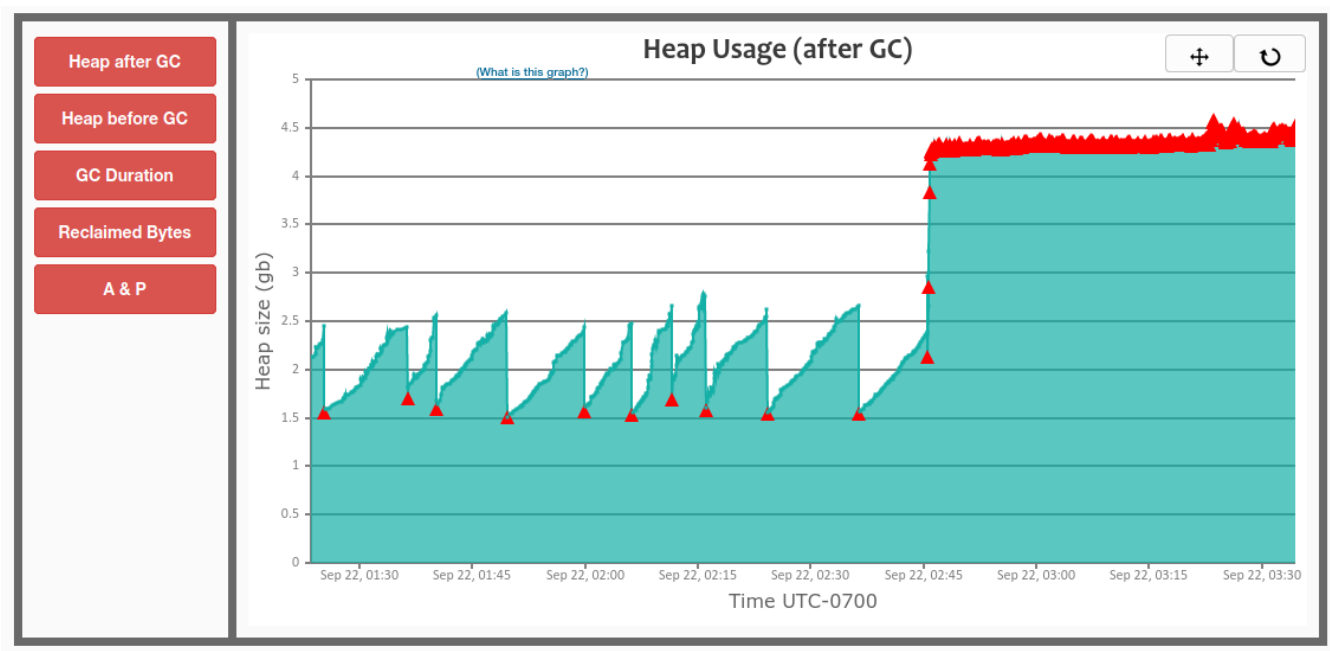
```
WARNING [DataReaderSun1_6_0]: com.tagtraum.perf.gcviewer.imp.ParseException: com.tagtraum.perf.gcviewer.imp.
UnknownGcTypeException: Unknown gc type: '-' Line 1: [2020-09-19T22:16:23.955-0700][2273876.179s] GC(326262)
ParOldGen: 2230694K->2232246K(2380800K)
```




After making the `-Xlog:gc` tweak suggested in the intro, and restarting Jira, GCViewer should be able to load the `/opt/atlassian/jira/logs/atlassian-jira-gc-*.log` files:

(example from a perfectly healthy server, sorry)




## GCEasy.io

Discovered after reading these GC tuning tips; https://gceasy.io is likely worth the $10/mo. Unlike GCViewer, no `-Xlog:gc` tweaks are needed. The free tier is enough to give a general idea of GC activity: