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Troubleshooting Memory Problems in Java Applications

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Java Your Next (Cloud)

Safe Harbor Statement

Agenda

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1. Symptoms of memory related issues
2. Step 1: Understand the underlying problem
3. Step 2: Collect the Diagnostic data
4. Step 3: Analyze the data to find the issue
5. Demo examples

Symptoms of memory related issues

- Application Failure with java.lang.OutOfMemoryError
- Unexpected Memory growth
- Poor Application performance

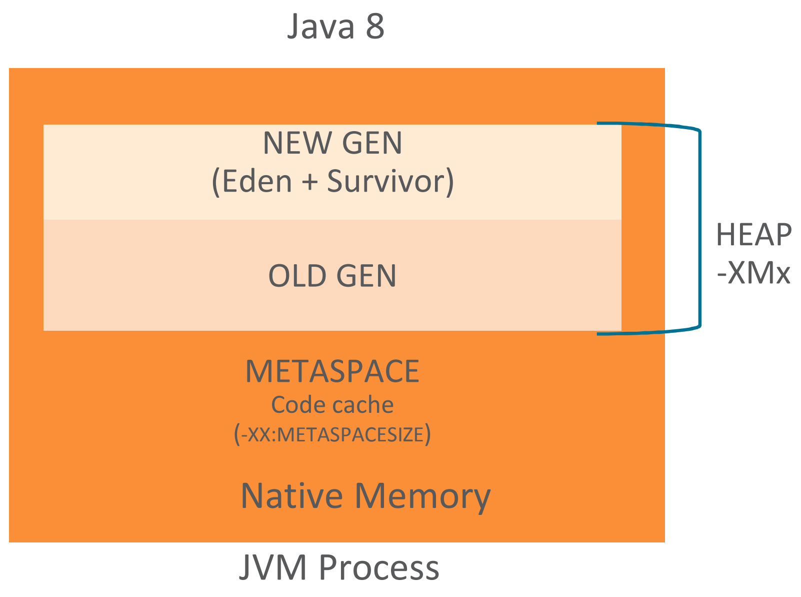
- GC activities
- Long GC pauses
- Excessive GC's

Agenda

1. Understand the underlying problem

- Misconfiguration of memory pools
- Excessive use of Finalizers
- Explicit GC invocation
- Memory leaks
- User Errors

1. Understand the underlying problem



1. Understand the underlying problem

Causes of java.lang.OutOfMemoryError

- java.lang.OutOfMemoryError: Java heap space
- java.lang.OutOfMemoryError: GC overhead limit exceeded
- java.lang.OutOfMemoryError: Unable to create new native thread
- java.lang.OutOfMemoryError: Metaspace/Compressed class space
- java.lang.OutOfMemoryError: Out of swap space?
- java.lang.OutOfMemoryError: Requested array size exceeds VM limit

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2. Collect the Diagnostic data

- **GC logs** (-Xlog:gc, -XX:+PrintGCDetails,-XX:+PrintGCTimeStamps)
  - Very helpful in determining the heap requirements
  - Excessive GC's
  - Long GC Pauses
- **Heap dumps** (jmap, jcmd, jvisualvm, java mission control,-XX:+HeapDumpOnOutofMemoryError)
  - Most important data for analyzing any memory related issues
- **Heap histograms** (jmap, jcmd, jvisualvm, java mission control,-XX:+PrintClassHistogram, SIGQUIT,SIGBREAK)
  - Quick view on objects and allocation in heap

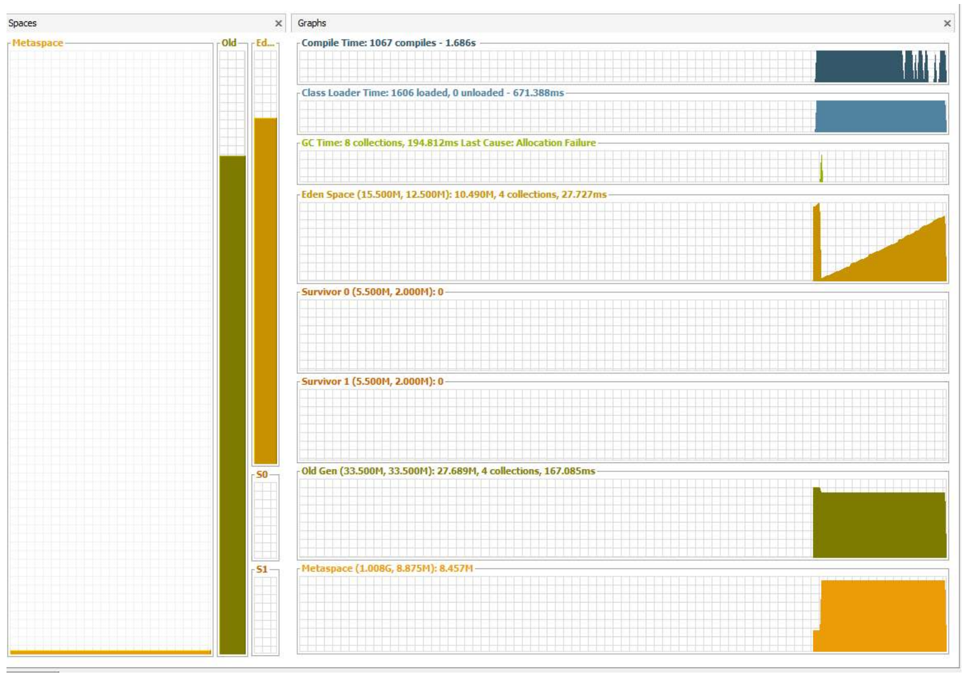
2. Collect the Diagnostic data

```
164638.058: [Full GC (System) [PSYoungGen: 22789K->0K(992448K)]
[PSOldGen: 1645508K->1666990K(2097152K)] 1668298K->1666990K(3089600K)
[PSPermGen: 164914K->164914K(166720K)], 5.7499132 secs] [Times: user=5.69 sys=0.06, real=5.75 secs]
```

```
[Full GC (Ergonomics) [PSYoungGen: 48341K->44325K(59904K)] [ParOldGen: 133231K->136249K(136704K)] 181572K->180574K(196608K),
[Metaspace: 2628K->2628K(1056768K)], 2.0914060 secs] [Times: user=5.54 sys=0.02, real=2.09 secs]
[Full GC (Allocation Failure) [PSYoungGen: 44325K->44325K(59904K)] [ParOldGen: 136249K->136235K(136704K)] 180574K-
>180560K(196608K), [Metaspace: 2628K->2628K(1056768K)], 1.1300763 secs] [Times: user=3.98 sys=0.00, real=1.13 secs]
Exception in thread "main" java.lang.OutOfMemoryError: Java heap space
at java.util.Arrays.copyOf(Arrays.java:3210)
at java.util.Arrays.copyOf(Arrays.java:3181)
at java.util.ArrayList.grow(ArrayList.java:261)
at java.util.ArrayList.ensureExplicitCapacity(ArrayList.java:235)
at java.util.ArrayList.ensureCapacityInternal(ArrayList.java:227)
at java.util.ArrayList.add(ArrayList.java:458)
at oom.Wrapper.main(Wrapper.java:12)
Heap
 PSYoungGen      total 59904K, used 46382K [0x00000000fbd80000, 0x0000000100000000, 0x0000000100000000)
  eden space 51712K, 89% used [0x00000000fbd80000,0x00000000feacba40,0x00000000ff000000)
  from space 8192K, 0% used [0x00000000ff000000,0x00000000ff000000,0x00000000ff800000)
  to   space 8192K, 0% used [0x00000000ff800000,0x00000000ff800000,0x0000000100000000)
 ParOldGen       total 136704K, used 136235K [0x00000000f3800000, 0x00000000fbd80000, 0x00000000fbd80000)
  object space 136704K, 99% used [0x00000000f3800000,0x00000000fbd0aeb0,0x00000000fbd80000)
 Metaspace       used 2660K, capacity 4486K, committed 4864K, reserved 1056768K
  class space    used 287K, capacity 386K, committed 512K, reserved 1048576K
```

2. Collect the Diagnostic data

Visual GC from Visual VM



Compile Time: 1067 compiles - 1.686s

Class Loader Time: 1606 loaded, 0 unloaded - 671.388ms

GC Time: 8 collections, 194.812ms Last Cause: Allocation Failure

Eden Space (15.500M, 12.500M): 10.490M, 4 collections, 27.727ms

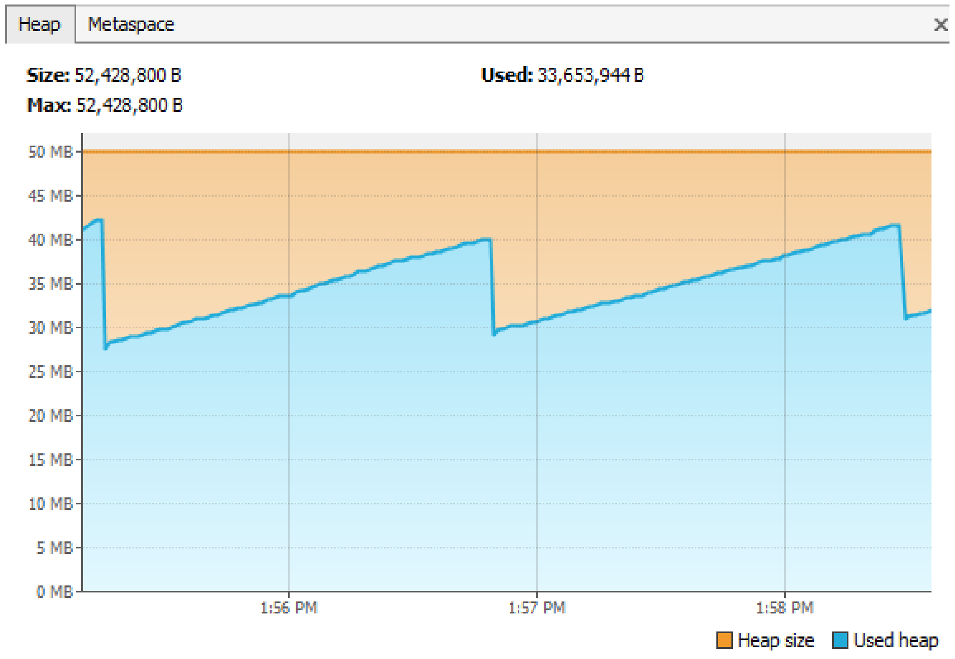
Survivor 0 (5.500M, 2.000M): 0

Survivor 1 (5.500M, 2.000M): 0

Old Gen (33.500M, 33.500M): 27.689M, 4 collections, 167.085ms

Metaspace (1.008G, 8.875M): 8.457M

Heap Allocation from Visual VM



Size: 52,428,800 B **Used:** 33,653,944 B
Max: 52,428,800 B

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3. Analyze the data to find the issue

Use the right tool to find the exact problem

Solution to common problems

1. Use Appropriate heap size using -Xmx option (Make sure you have enough memory)
2. Do not use explicit GC calls (System.gc())
3. Avoid finalizers (Deprecated - JDK-8165641)
4. Avoid user errors while handling memory operations/ opening closing file handles or any resources

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Demo 1: java.lang.OutOfMemoryError: Java heap space

```
Exception in thread "main" java.lang.OutOfMemoryError: Java heap space
        at java.util.Arrays.copyOf(Arrays.java:3210)
        at java.util.Arrays.copyOf(Arrays.java:3181)
        at java.util.ArrayList.grow(ArrayList.java:261)
        at java.util.ArrayList.ensureExplicitCapacity(ArrayList.java:235)
        at java.util.ArrayList.ensureCapacityInternal(ArrayList.java:227)
        at java.util.ArrayList.add(ArrayList.java:458)
        at oom.Wrapper.main(Wrapper.java:12)
```

Demo 2: " java.lang.OutOfMemoryError: unable to create new native thread

```
Exception in thread "main" java.lang.OutOfMemoryError: unable to create new native thread
	at java.lang.Thread.start0(Native Method)
	at java.lang.Thread.start(Thread.java:717)
	at oom.GC_NativeOOM.main(GC_NativeOOM.java:13)
```

Demo 2: " java.lang.OutOfMemoryError: unable to create new native thread

Debug:
1. Use Task manager to track usage
2. Start application with -XX:NativeMemoryTracking=summary or -XX:NativeMemoryTracking=detail

Jcmd to monitor the NMT (native memory tracker)
Jcmd <pid> VM.native_memory baseline
Jcmd <pid> VM.native_memory detail.diff

Demo 3: " java.lang.OutOfMemoryError: GC overhead limit exceeded

```
Exception in thread "main" java.lang.OutOfMemoryError: GC overhead limit exceeded
Dec 11, 2017 8:58:11 PM sun.rmi.transport.tcp.TCPTransport$AcceptLoop executeAcceptLoop
WARNING: RMI TCP Accept-0: accept loop for ServerSocket[addr=0.0.0.0/0.0.0.0,localport=57280]
throws
java.lang.OutOfMemoryError: GC overhead limit exceeded
at java.net.NetworkInterface.getAll(Native Method)
at java.net.NetworkInterface.getNetworkInterfaces(NetworkInterface.java:343)
at
sun.management.jmxremote.LocalRMIServerSocketFactory$1.accept(LocalRMIServerSocketFactor
y.java:86)
at sun.rmi.transport.tcp.TCPTransport$AcceptLoop.executeAcceptLoop(TCPTransport.java:400)
at sun.rmi.transport.tcp.TCPTransport$AcceptLoop.run(TCPTransport.java:372)
at java.lang.Thread.run(Thread.java:748)
```

References

- https://www.youtube.com/watch?v=iixQAYnBnJw
- https://bugs.openjdk.java.net/browse/JDK-8165641
- https://www.ibm.com/developerworks/java/library/j-nativememory-linux/

Q&A

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