


```
###
```

1. **`df` `/` **
- `df` 16GB
- `df` 15.97GB (99.8%)
- `df` 186MB (1.2%)
- `df` 2.3GB ()

2. **`df` `/` **
- `df` 4GB
- `df` 1.3MB (0.03%)
- `df` 10.5% ()

3. **`df` `/` **
- Active 12.4GB (11.1GB)
- Inactive 2.8GB

```
##
```

1. **Tomcat `ps` **
- RSS(5.26GB) > Xmx(4GB) + MaxDirectMemory(1GB)
- `ps`
* JNI
* `ps` JVM
* `ps` (`-Xss`)

2. **swappiness `cat` **
- `cat` 0 OOM swap
- `cat`
``bash
cat /proc/sys/vm/swappiness
``

3. **MySQL `ps` **
- `ps` InnoDB

```
##
```

```
###
```

```
``bash  
# df ( )  
sync; echo 1 > /proc/sys/vm/drop_caches
```

```
# ps Tomcat( )  
systemctl restart tomcat  
``
```

```
### JVM
```

```
```bash
```

```
JDK
```

```
apt-get install -y openjdk-8-jdk
```

```
Tomcat
```

```
jcmd 31037 VM.native_memory summary
```

```
root@shuncom-01:~# jcmd 31037 VM.native_memory summary
31037:
Native Memory Tracking:
Total: reserved=6165979KB, committed=4780715KB
- Java Heap (reserved=4194304KB, committed=3899392KB)
 (mmap: reserved=4194304KB, committed=3899392KB)
- Class (reserved=1280500KB, committed=260596KB)
 (classes #37630)
 (malloc=10740KB #71177)
 (mmap: reserved=1269760KB, committed=249856KB)
- Thread (reserved=186976KB, committed=186976KB)
 (thread #179)
 (stack: reserved=182984KB, committed=182984KB)
 (malloc=588KB #896)
 (arena=3405KB #356)
- Code (reserved=273364KB, committed=203492KB)
 (malloc=23764KB #19623)
 (mmap: reserved=249600KB, committed=179728KB)
- GC (reserved=159054KB, committed=158478KB)
 (malloc=5810KB #1350)
 (mmap: reserved=153244KB, committed=152668KB)
- Compiler (reserved=615KB, committed=615KB)
 (malloc=484KB #857)
 (arena=131KB #3)
- Internal (reserved=19846KB, committed=19846KB)
 (malloc=19814KB #46359)
 (mmap: reserved=32KB, committed=32KB)
- Symbol (reserved=44112KB, committed=44112KB)
 (malloc=40268KB #288206)
 (arena=3844KB #1)
- Native Memory Tracking (reserved=7077KB, committed=7077KB)
 (malloc=300KB #4658)
 (tracking overhead=6777KB)
- Arena Chunk (reserved=131KB, committed=131KB)
 (malloc=131KB)
```

```
jmap -histo:live 31037 | head -20
```

```
root@shuncom-01:~# jmap -histo:live 31037 | head -20
```

num	#instances	#bytes	class name
1:	550669	379776624	[C
2:	25173	171052792	[B
3:	546122	13106928	java.lang.String
4:	235518	9420720	java.util.LinkedHashMap\$Entry
5:	102432	8554088	[Ljava.lang.Object;
6:	116858	8413776	org.apache.jasper.compiler.Node\$TemplateText
7:	94211	8290568	java.lang.reflect.Method
8:	96381	7375384	[Ljava.util.HashMap\$Node;
9:	222013	7104416	java.util.concurrent.ConcurrentHashMap\$Node
10:	107867	6040552	java.util.LinkedHashMap
11:	124835	4993400	org.apache.jasper.compiler.Mark
12:	39744	4404984	java.lang.Class
13:	19634	4289136	[I
14:	120823	3866336	java.util.HashMap\$Node
15:	224151	3586416	java.lang.Integer
16:	9596	2736488	[Ljava.util.concurrent.ConcurrentHashMap\$Node;
17:	101173	2428152	java.util.ArrayList

```
...
```

```
[] [] [] [] [] []
```

```
1. **Tomcat [] [] ** []
```

```
``diff
```

```
- -XX:MaxDirectMemorySize=1024m
+ -XX:MaxDirectMemorySize=512m
+ -XX:NativeMemoryTracking=summary
+ -XX:+AlwaysPreTouch
```

```
...
```

```
2. **MySQL [] [] ** []
```

```
``ini
```

```
/etc/mysql/my.cnf
```

```
[mysqld]
```

```
innodb_buffer_pool_size = 1G
```

```
innodb_buffer_pool_instances = 4
```

```
...
```

```
3. ** [] [] [] [] [] [] ** []
```

```
``bash
```

```
[] [] OOM killer [] []
```

```
echo 'vm.panic_on_oom=2' >> /etc/sysctl.conf
```

```
echo 'vm.overcommit_memory=2' >> /etc/sysctl.conf
```

```
sysctl -p
```

```
...
```

```
4. ** [] [] [] [] ** []
```

```
``bash
```

```
[] [] [] [] [] []
```

```
apt-get install -y sysstat valgrind
```



```

- **[] [] [] [] [] [] [] [] [] [] HTTP Session [] []
- **[] [] [] [] [] [] [] [] [] []

**2. [] [] [] [] **
**2.1 MetaSpace [] [] **
- **Class Metadata [] [] 260MB**[] [] [] [] **37,630 [] [] **[]
- **[] [] [] [] **[]
- **[] [] [] [] **[] JSP [] [] [] [] [] [] [] []
- **[] [] [] [] MetaSpace**[] [] [] [] [] [] [] [] [] []

**2.2 [] [] [] [] **
- **179 [] [] **[] [] [] [] [] [] [] [] **1MB**[] [] [] `Xss1m`[] []
- **[] [] [] [] **[] 179 x 1MB ≈ **179MB**[] []
- **[] [] [] [] **[]
- **[] [] [] [] [] [] **[] Tomcat `maxThreads=200`[]
- **[] [] [] [] **[] [] [] [] [] [] [] [] [] []

**2.3 Direct Memory [] [] **
- `XX:MaxDirectMemorySize=1024m` [] [] [] [] **1GB [] [] [] **[]
- **NIO Buffer [] Netty [] [] [] [] [] [] Direct Memory**[] []

**3. [] [] [] [] **
**3.1 JVM [] [] [] [] **
```diff
# [] [] Tomcat [] [] [] [] catalina.sh [] setenv.sh[]
- -Xms2048m -Xmx4096m -XX:MaxDirectMemorySize=1024m
+ -Xms2048m -Xmx4096m
+ -XX:MaxDirectMemorySize=512m # [] [] Direct Memory
+ -XX:MaxMetaspaceSize=256m # [] [] MetaSpace [] [] [] []
+ -Xss256k # [] [] [] [] [] []
+ -XX:+UseG1GC # [] [] G1 [] [] [] []
+ -XX:NativeMemoryTracking=detail # [] [] [] [] Native Memory
```

**3.2 [] [] [] [] **
```bash
# [] [] Tomcat [] [] [] []
ps -L -p 31037 | wc -l

# [] [] [] [] [] []
jstack 31037 > /tmp/jstack.log
grep "pool-" /tmp/jstack.log | wc -l
```

```



```
**5. [] **
- **[] [] **
- **MetaSpace [] ** 260MB[] `MaxMetaspaceSize` []
- **[] ** 179MB[] `-Xss` [] `maxThreads` []
- **Direct Memory [] ** [] NIO Buffer []
- **Heap [] `char[]` [] `byte[]` [] ** []

- **[] **
- **RSS [] 1-2GB** [] 5.26GB → 3.5GB []
- ** [] OOM [] ** []

[] ** [] Tomcat** [] JVM []
```

```
root@shuncom-01:/usr/local/apache-tomcat-8.0.39/bin# jcmd 31037 VM.native_memory detail |
grep "Java Heap\|Direct"
```

```
- Java Heap (reserved=4194304KB, committed=3646976KB)
[0x00000006c0000000 - 0x00000007c0000000] reserved 4194304KB for Java Heap from
```

```
root@shuncom-01:/usr/local/apache-tomcat-8.0.39/bin# jcmd 31037 VM.class_hierarchy | grep
Generated
```

```
java.io.IOException: Command failed in target VM
 at sun.tools.attach.LinuxVirtualMachine.execute(LinuxVirtualMachine.java:224)
 at sun.tools.attach.HotSpotVirtualMachine.executeCommand(HotSpotVirtualMachine.java:217)
 at sun.tools.attach.HotSpotVirtualMachine.executeJCmd(HotSpotVirtualMachine.java:199)
 at sun.tools.jcmd.JCmd.executeCommandForPid(JCmd.java:150)
 at sun.tools.jcmd.JCmd.main(JCmd.java:129)
```

```
root@shuncom-01:/usr/local/apache-tomcat-8.0.39/bin# jcmd 31037 GC.class_stats | head -20
```

```
31037:
GC.class_stats command requires -XX:+UnlockDiagnosticVMOptions
```

```
???????????????? Tomcat ?? (PID 31037) ? [] [] ? [] [] ?
```

---

```
**1. [] **
**1.1 Java Heap [] **
- ** [] ** `-Xmx4096m` (4GB)
- ** [] Commit** [] 3.64GB [] OOM []
- ** [] ** Heap []
- [] HTTP Session []
- [] `char[]` [] 379MB []
```

```
1.2 Direct Memory
- ** [] Direct Buffer [] ** `grep "Direct"` []
- [] `-XX:MaxDirectMemorySize=1024m` [] NIO [] Netty []
```



