JBoss Performance Tuning

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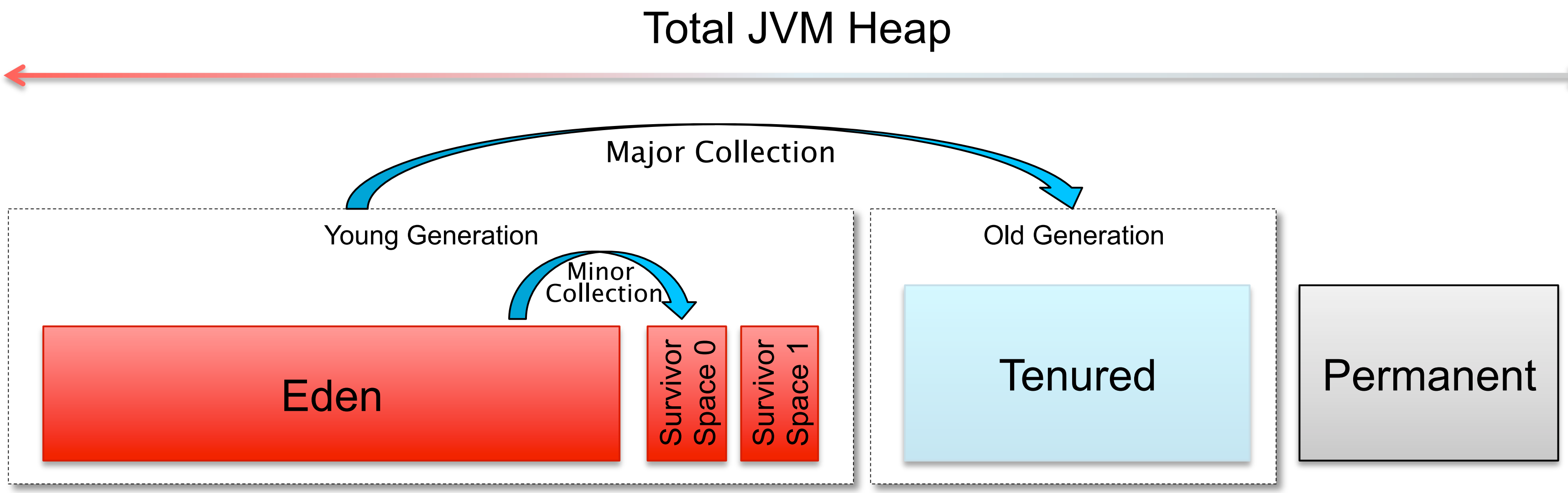
JVM Memory Tuning

JVM Heap



- Young generation
  - Objects are initially allocated in eden
  - One survivor space is empty at any time, and serves as the destination of any live objects in eden and the other survivor space during the next copying collection.
  - Objects are copied between survivor spaces until they are old enough to be tenured (copied to the tenured generation).
- Old/Tenured generation
  - Where objects are moved to that survive the 1st major garbage collection
- Permanent
  - Where metadata describing classes and methods reside. Also used for String pools

Two Types of Collections

- Minor Collection
  - Occurs when the Young Generation is full
  - Low impact on performance (smaller, targeted area)
- Major Collection
  - Involves scanning the entire Java heap
  - MANY objects to look at
  - Cause of most performance bottlenecks

JVM Tuning – Basic Steps

1. Tune the JVM heap size
2. Tune the Young/Tenured Generation Ratio
3. Tune the correct garbage collector algorithm

Step 1 – Tune the JVM Heap Size

- To tune the JVM-
  - Identify the appropriate maximum heap size for the application and then set initial heap size to match
  - Use the (-Xms) and (-Xmx) arguments
  - For J2SE 5.0 and above, initial and max heap size is based on hardware specs (# of cpu cores and memory)

Step 1 – Tune the JVM Heap Size

Max Heap Size

- Set the max heap size-
  - Simply monitor application under load (jstat, jvisualvm, JBoss Operations Network, etc.)
  - Add 25-30% to the peak heap size for buffer
  - Added buffer will help reduce the frequency of garbage collection
  - Leave room for other running applications!

Step 1 – Tune the JVM Heap Size

Initial Heap Size

- Set the initial heap size-
  - For non-development-
    - Set it to be the same as the maximum heap size.
    - Increases predictability and avoids the need to allocate memory to expand the heap.
  - For development-
    - Somewhere between default and max heap size is fine.

Step 2 - Tune the Young/Tenured Generation Ratio

- Choose a correct ratio between Young and Tenured based on application characteristics
  - Large # of short-lived objects
    - Increase size of Young Generation
  - Large # of long-lived objects
    - Increase size of Tenured Generation
    - Examples- pools, caches, data that lives for the life of the application
- For most applications-
  - Optimal size is 1/3 to ½ of the heap
- Must also tune the Survivor Space size!

Monitor Garbage Collections in realtime

- Use the jstat utility with the –gcutil argument
  - `$ jstat –gcutil –h5 <pid> 2s`
- Outputs stats on garbage collection for a running Java Virtual Machine

Column	Description
S0	Survivor space 0 utilization as a percentage of the space's current capacity.
S1	Survivor space 1 utilization as a percentage of the space's current capacity.
E	Eden space utilization as a percentage of the space's current capacity.
O	Old space utilization as a percentage of the space's current capacity.
P	Permanent space utilization as a percentage of the space's current capacity.
YGC	Number of young generation GC events.
YGCT	Young generation garbage collection time.
FGC	Number of full GC events.
FGCT	Full garbage collection time.
GCT	Total garbage collection time.

- http://docs.oracle.com/javase/1.5.0/docs/tooldocs/share/jstat.html#gcutil_option

Young vs. Tenured Example

- Two approaches- ratio vs. size
- Ratio Example: -XX:NewRatio=3
  - Means ratio between tenured and young is 3:1
  - That is-
    - tenured occupies 3/4th the total heap
    - eden + survivor spaces occupies the other 1/4th total heap
- Size Example: -XX:NewSize & -XX:MaxNewSize
  - Bind the young (new) generation size from below and above.
  - Setting these equal to one another fixes the Young generation (just like -Xms and –Xmx fixes the heap size).
  - Allows for finer tuning than the integral multiples allowed by NewRatio.

Default JBoss JVM Arguments

- EAP5/EAP6 VM Arguments:
  - -XX:+UseCompressedOops
  - -Xms1303m
  - -Xmx1303m
  - -XX:MaxPermSize=256m
  - -Djava.net.preferIPv4Stack=true
  - -Dsun.rmi.dgc.client.gcInterval=3600000
  - -Dsun.rmi.dgc.server.gcInterval=3600000

Step 3 - Tune the GC Algorithm

- Garbage collection-
  - a mechanism provided by Java Virtual Machine to reclaim heap space from objects, which are eligible for Garbage collection.
- Eligibility-
  - if an object is not reachable from any live threads
  - any static references.
  - In other words, an object becomes eligible for Garbage collection if all its references are null.
- Choosing the correct Garbage collector algorithm plays an important role in application performance, responsiveness, and throughput.
- There are several garbage collectors available

Step 3 - Tune the GC Algorithm

Selecting the Serial Collector

- Serial collector (-XX:+UseSerialGC)
  - Performs garbage collector using a single thread which stops other JVM threads
  - Ideal for smaller applications (<100MB data set); not recommended for production deployments
- Use when
  - Application runs on a single processor
  - No pause time requirements

Step 3 - Tune the GC Algorithm

Selecting the Parallel Collector

- Parallel collector (-XX:+UseParallelGC)
  - Performs minor collections and major (J2SE >= 5.0) in parallel.
  - (Optionally) Enable parallel compaction (+UseParallelOldGC).
  - Ideal for multiprocessor machines and applications requiring high throughput.
  - Also good for applications which fragmented Java heaps, allocating large-size objects at different timelines.
  - Default parallel collector runs a collection thread per processor core. Can be overridden with (-XX:ParallelGCThreads=#).
- Use when
  - Peak application performance is 1st priority
  - Either no pause time requirements or > one second are ok

Step 3 - Tune the GC Algorithm

Selecting the Concurrent Collector

- Concurrent collector (-XX:+UseConcMarkSweepGC)
  - Performs most of its work concurrently using a single garbage collector thread that runs with the application threads simultaneously.
  - Best when used with fast processor machines and applications with a strict service-level agreement.
  - Can be the best choice, also for applications using a large set of long-lived objects live HttpSessions.
- Use when
  - Application response time is more important than overall throughput
  - Garbage collections must be kept < 1 second

JVM Resource Tuning

Tuning Resource Pools

- Application server resource pools
  - Improves performance by pooling resources that are expensive to create
    - eg., maintain open database connections so they are available when requested
  - Improves security by setting limits to the number of resources that can exist at a time
    - eg., limit the number of worker threads for web requests
- EAP6 uses several resource pools to manage different kind of services
  - Default configuration for all resource pools to handle generic use cases
  - For mission-critical applications, identify the appropriate number of resources to be assigned to your pools.
- Tunable resource pools-
  - JDBC connection pool
  - EJB pool used by Stateless EJBs and MDBs
  - Web server pool of threads

Tuning JDBC pools

- Creating JDBC connections is very slow!
  - Use JDBC pools to cache open connections for use-on-demand.
  - Closed connections are simply returned to the pool and reused in future requests
- To determine the proper sizing, you need to monitor your connection usage.

`<min-pool-size>`

- Specifies a minimum number of connections to keep open

`<prefill>`

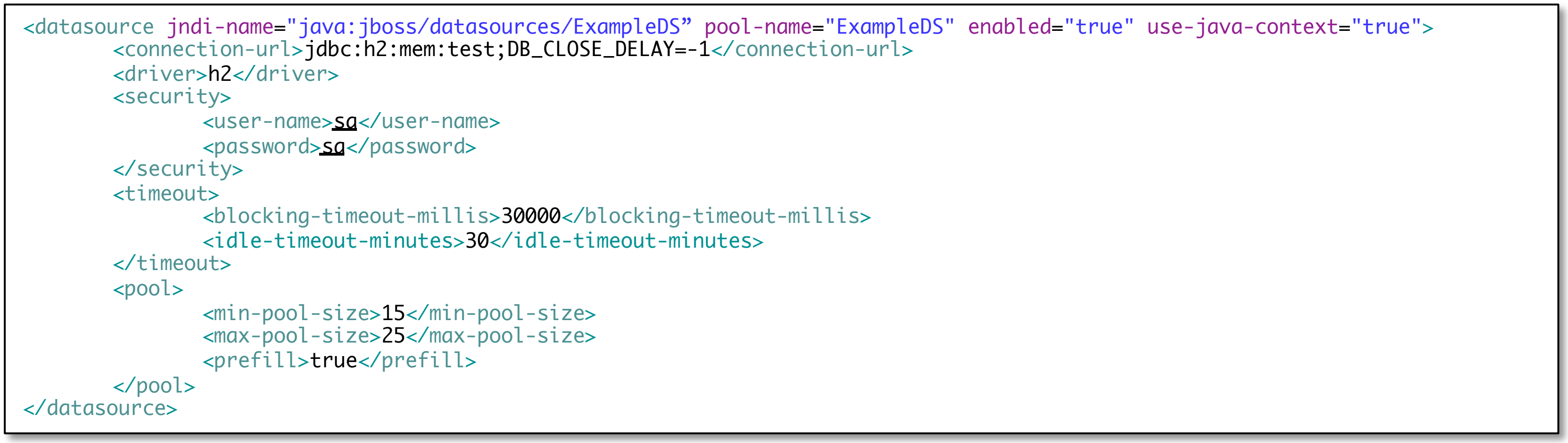
- Used to pre-create connections on startup; use with caution
- This can produce a performance hit, especially if your connections are costly to acquire.

`<blocking-timeout-millis>`

- Used to minimize how long requests block waiting for a connection

`<idle-timeout-minutes>`

- Indicates how long a connection may be idle before being closed



```
<datasource jndi-name="java:jboss/datasources/ExampleDS” pool-name="ExampleDS" enabled="true" use-java-context="true">
        <connection-url>jdbc:h2:mem:test;DB_CLOSE_DELAY=-1</connection-url>
        <driver>h2</driver>
        <security>
                <user-name>sa</user-name>
                <password>sa</password>
        </security>
        <timeout>
                <blocking-timeout-millis>30000</blocking-timeout-millis>
                <idle-timeout-minutes>30</idle-timeout-minutes>
        </timeout>
        <pool>
                <min-pool-size>15</min-pool-size>
                <max-pool-size>25</max-pool-size>
                <prefill>true</prefill>
        </pool>
</datasource>
```

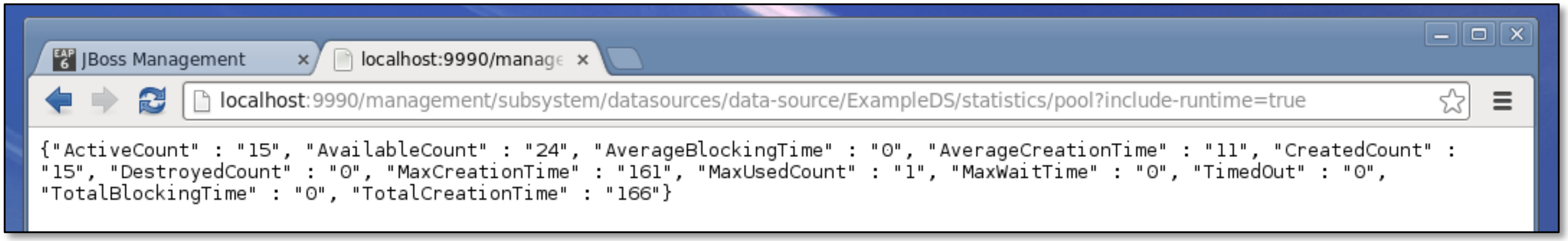
Monitor the JDBC pool size

- Use the CLI to look at the runtime stats for your datasource
- Interested in these statistics-
    - ActiveCount - displays the amount of connections which are currently active
    - MaxUsedCount - the peak connections used by the application

```
[standalone@localhost:9999 /] /subsystem=datasources/data-source=ExampleDS/
statistics=pool:read-resource(include-runtime=true)
{
    "outcome" => "success",
    "result" => {
        "ActiveCount" => "15",
        "AvailableCount" => "24",
        "AverageBlockingTime" => "0",
        "AverageCreationTime" => "11",
        "CreatedCount" => "15",
        "DestroyedCount" => "0",
        "MaxCreationTime" => "161",
        "MaxUsedCount" => "1",
        "MaxWaitTime" => "0",
        "TimedOut" => "0",
        "TotalBlockingTime" => "0",
        "TotalCreationTime" => "166”
    },
    "response-headers" => {"process-state" => "reload-required”}
}
```

Monitor the JDBC pool size

- Or the Web Console (with special URL!)


JBoss Management
localhost:9990/manage
localhost:9990/management/subsystem/datasources/data-source/ExampleDS/statistics/pool?include-runtime=true

```
{"ActiveCount" : "15", "AvailableCount" : "24", "AverageBlockingTime" : "0", "AverageCreationTime" : "11", "CreatedCount" :
"15", "DestroyedCount" : "0", "MaxCreationTime" : "161", "MaxUsedCount" : "1", "MaxWaitTime" : "0", "TimedOut" : "0",
"TotalBlockingTime" : "0", "TotalCreationTime" : "166"}
```

Adjust the JDBC pool size

- Set `<max-pool-size>` to be 25% greater `MaxUsedCount`.
- Pools will shrink automatically, provided that you have set `<idle-timeout-minutes>`.
- Watch the server logs for exceptions-

  -
    ```
    13:42:12,424 ERROR [stderr] (http-executor-threads - 4) Caused by:
    javax.resource.ResourceException: IJ000655: No managed connections
    available within configured blocking timeout (30000 [ms])
    ```

  -
    ```
    13:42:12,427 ERROR [stderr] (http-executor-threads – 4)at
    org.jboss.jca.core.connectionmanager.pool.mcp.SemaphoreArrayListMana
    gedConnectionPool.getConnection
    ```
- Use JBoss Operations Network to monitor pool sizes for you!

Tuning EJB Pools

- Like JDBC pools, EJB pools are used to cache previously created EJBs
- EJB creation and destruction can be expensive operations
- Reduces overheard of reinitializing beans everytime they are needed
- Two pools provided-
  - Stateless EJB pool
  - MDB pool

Tuning EJB Pools

- A typical EJB pool configuration looks like the following:

```
<pools>
    <bean-instance-pools>
        <strict-max-pool name="slsb-strict-max-pool” max-pool-size="20”
            instance-acquisition-timeout="5”
            instance-acquisition-timeout-unit="MINUTES" />
        <strict-max-pool name="mdb-strict-max-pool” max-pool-size="20”
            instance-acquisition-timeout="5”
            instance-acquisition-timeout-unit="MINUTES" />
    </bean-instance-pools>
</pools>
```

- strict-max-pools are pools with a maximum upper limit
- Once max limit is reached-
  - Requests will block waiting for a new bean
  - Or until the acquisition timeout is reached

Tuning Web Pools

Step 1

Define a new Thread Pool that will be used to service HTTP requests:

```
<subsystem xmlns="urn:jboss:domain:threads:1.1">
    <bounded-queue-thread-pool name="http-executor">
        <core-threads count="10" per-cpu="20" />
        <queue-length count="10" per-cpu="20" />
        <max-threads count="10" per-cpu="20" />
        <keepalive-time time="10" unit="seconds" />
    </bounded-queue-thread-pool>
</subsystem>
```

Tuning Web Pools

Step 2

For the HTTP connector, specify the Thread Pool using the executor attribute:

```
<subsystem xmlns="urn:jboss:domain:web:1.1” default-virtual-server="default-host"
native="false">
    <connector name="http" protocol="HTTP/1.1" scheme="http”
        socket-binding="http" enabled="true" enable-lookups="false”
        executor="http-executor" max-connections="200" max-post-size="2048”
        max-save-post-size="4096" proxy-name="proxy" proxy-port="8081”
        redirect-port="8" secure="false" />

    <virtual-server name="default-host” enable-welcome-root="true">
        <alias name="localhost" />
        <alias name="example.com" />
    </virtual-server>
</subsystem>
```

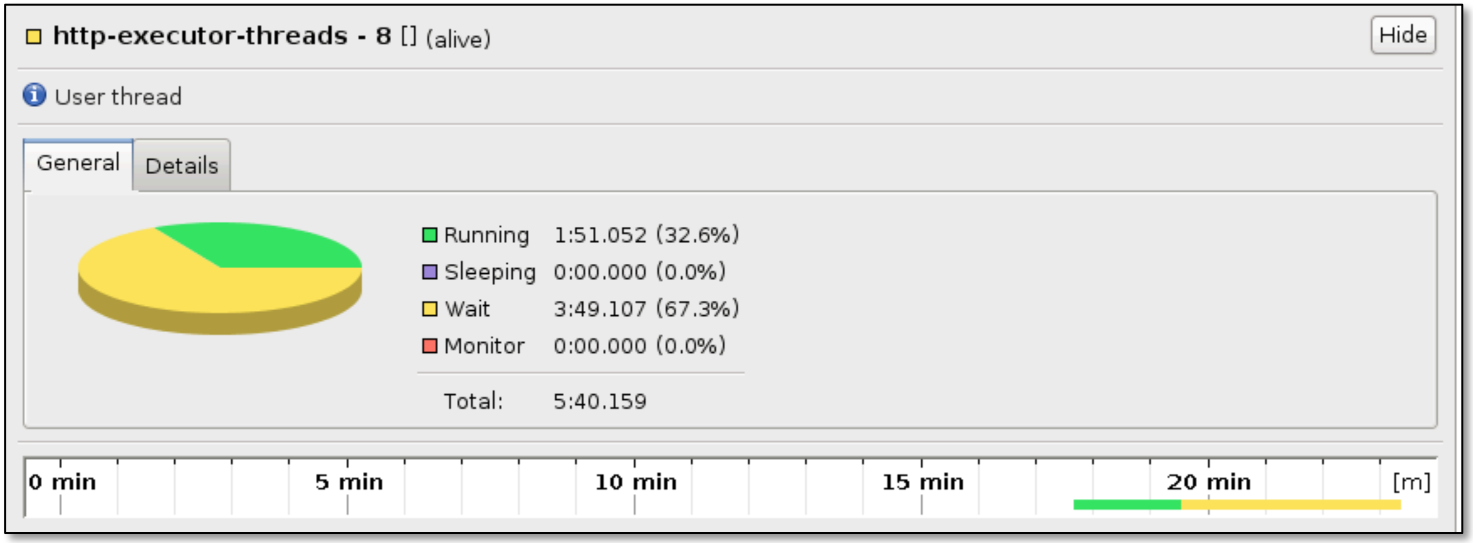
Tuning Web Pools

- Tune the <core-threads> and <max-threads> attributes.
  - Set too low-
    - App server may not have enough threads to handle all of the requests
    - Requests will sit idle waiting for another request thread to free up.
  - Set too high-
    - Consume a good chunk of memory
    - Your system will spend too much time-context switching

Tuning Web Pools

- Use jvisualvm to see thread states
- Good-
  - Running threads
  - Sleeping threads

- Suspicious-
  - Wait
    - Too many executor threads and not enough work?
    - Consuming resources unnecessarily



□ http-executor-threads - 8 [] (alive)

User thread

🟩 Running 1:51.052 (32.6%)
🟪 Sleeping 0:00.000 (0.0%)
🟨 Wait 3:49.107 (67.3%)
🟥 Monitor 0:00.000 (0.0%)

Total: 5:40.159

Log Performance Tuning

- Disable console logging-

```
<root-logger>
    <level name="INFO" />
    <handlers>
    <!–
        <handler name="CONSOLE" />
    -->
        <handler name="FILE" />
    </handlers>
</root-logger>
```

Log Performance Tuning

- Adjust verbosity as needed-

```
…
<logger category=”com.arjuna">
    <level name=”ERROR" />
</logger>
<logger category=”org.hibernate">
    <level name="WARN" />
</logger>
…
```

Log Performance Tuning

- Log patterns can influence the performance of your applications

- EAP6 default-

```
<pattern-formatter pattern=
        "%d{HH:mm:ss,SSS} %-5p [%c] (%t) %s%E%n" />
```

Log Performance Tuning

- Simply adding the %l flag-

```
<pattern-formatter
    pattern="%l %d{HH:mm:ss,SSS} %-5p [%c] (%t) %s%E%n" />
```

- Adds class and line number info-

```
org.jboss.as.configadmin.parser.ConfigAdminAdd.performBoottime(
ConfigAdminAdd.java:73) 19:16:52,862 INFO  [org.jboss.as.configadmin]
(ServerService Thread Pool -- 26) JBAS016200: Activating ConfigAdmin Subsystem
```

- Great for development, horrible for production!

Log Performance Tuning

- Other high-overhead flags to avoid
  - %C – outputs the caller class information
  - %M - outputs the method where logging was emitted
  - %F - outputs the filename where the logging request was issued)

Questions?

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