Assignment 2 Write Up
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Github Url: https://github.com/tsanevp/CS6650-Assignment2

Data Model

Creating a data model for this assignment was fairly straightforward. In my servlet, the request process is as follows: send a POST request, create a UUID inside the servlet, return the UUID in the POST response (per API spec), parse that response in my client to get the UUID, and immediately use the UUID to send a GET request with that UUID. In my database, each UUID is used as a key to retrieve my ImageData and AlbumProfile information, both stored as JSON strings. This is explained in further detail in the following sections. See Image 1 for a model example.

```
CREATE TABLE albumRequests (
  AlbumID VARCHAR(255) PRIMARY KEY,
  ImageData VARCHAR(225),
  AlbumProfile VARCHAR(255)
);
```

Image 1: Database data model

Image

For this assignment, I used the image provided to us by Ian. The image size is 3,475 bytes. See the Image 2 below.

Image 2: The image used in Assignment 2.

Database Choice

Determining which database to use was challenging. From the options listed in the assignment description, the only database I had previous experience using was MongoDB. Given that MongoDB is a non-relational document database that provides support for JSON-like storage and fast key-value look-ups, it makes an excellent choice for this assignment. However, I wanted to try something new. After researching DynomoDB, YugabyteDB, Redis, and MySQL, I used AWS's RDS service to create a MySQL database.

MySQL Configuration

Typically, NoSQL databases are used with data in a flat key-value structure. However, with simple data like the ImageData and AlbumProfile, a correctly configured MySQL table suffices. To create a fast and efficient low-latency key-value store using Amazon RDS for MySQL, each entry to my table had a UUID named AlbumID defined as a Primary Key. I created my table, as seen below.

```sql
CREATE TABLE albumRequests (
  AlbumID VARCHAR(255) PRIMARY KEY,
  ImageData VARCHAR(225),
  AlbumProfile VARCHAR(255)
);
```

Image 3: SQL statement used to create albumRequests table.

Defining AlbumID as a Primary Key, an associated index is created, leading to fast query performance. ImageData and AlbumProfile are stored as JSON strings rather than the JSON data type to improve performance. Then, as long as I have a valid UUID, I can query either ImageData, AlbumProfile, or both. My GET requests only query and pull the AlbumProfile information, which is then returned in the response

Part 3 - Single Server/DB Results

Part 3 - Output Window Results

10/10/2 Configuration

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=55890:/Applications/IntelliJ
 IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
 .m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
 .0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
 .0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
 .m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
 .m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
 .m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
 .m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
 .m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
 .jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
 .m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 10 2 http://ec2-54-190-226-202.us-west-2.compute.amazonaws.com:8080/Server_Web
-----------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - 1 Servlet, 1 DB --------
Thread Groups = 10, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 200000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 2675.26 (req/sec) ---> total successful requests / wall time
Wall Time: 74.76 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 35.65 (ms)
Median Response Time: 33 (ms)
p99 Response Time: 77 (ms)
Min Response Time: 16 (ms)
Max Response Time: 302 (ms)
-- GET Requests --
Mean Response Time: 22.12 (ms)
Median Response Time: 20 (ms)
p99 Response Time: 50 (ms)
Min Response Time: 12 (ms)
Max Response Time: 223 (ms)
-------- End of Results For Loading Java Server Phase - 1 Servlet, 1 DB --------
```

Image 4: Screenshot of output window for 10/10/2 run configuration.

10/20/2 Configuration

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=57996:/Applications/IntelliJ
IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
.m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
.0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
.0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
.m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
.m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
.m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
.m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
.m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
.jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
.m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 20 2 http://ec2-54-190-226-202.us-west-2.compute.amazonaws.com:8080/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - 1 Servlet, 1 DB --------
Thread Groups = 20, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 400000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 3091.69 (req/sec) ---> total successful requests / wall time
Wall Time: 129.38 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 54.58 (ms)
Median Response Time: 50 (ms)
p99 Response Time: 135 (ms)
Min Response Time: 16 (ms)
Max Response Time: 607 (ms)
-- GET Requests --
Mean Response Time: 39.68 (ms)
Median Response Time: 37 (ms)
p99 Response Time: 102 (ms)
Min Response Time: 12 (ms)
Max Response Time: 498 (ms)
-------- End of Results For Loading Java Server Phase - 1 Servlet, 1 DB --------
```

Image 5: Screenshot of output window for 10/20/2 run configuration.

10/30/2 Configuration

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=62124:/Applications/IntelliJ
IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
.m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
.0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
.0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
.m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
.m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
.m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
.m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
.m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
.jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
.m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 30 2 http://ec2-54-190-226-202.us-west-2.compute.amazonaws.com:8080/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - 1 Servlet, 1 DB --------
Thread Groups = 30, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 600000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 3206.31 (req/sec) ---> total successful requests / wall time
Wall Time: 187.13 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 74.86 (ms)
Median Response Time: 62 (ms)
p99 Response Time: 301 (ms)
Min Response Time: 17 (ms)
Max Response Time: 988 (ms)
-- GET Requests --
Mean Response Time: 59.53 (ms)
Median Response Time: 47 (ms)
p99 Response Time: 254 (ms)
Min Response Time: 11 (ms)
Max Response Time: 1236 (ms)
-------- End of Results For Loading Java Server Phase - 1 Servlet, 1 DB --------
```

Image 6: Screenshot of output window for 10/30/2 run configuration.

Part 3 - Table Results

Table 1: Results for Part 3 of Assignment 2

	Overall Results				POST Calculated Response Times (ms)					GET Calculated Response Times (ms)				
Configuration	# Successful Requests	# Failed Requests	Throughput (req/sec)	Wall Time (sec)	Mean	Median	p99	Min	Max	Mean	Median	p99	Min	Max
10/10/2	200,000	0	2675.26	74.76	35.65	33	77	16	302	22.12	20	50	12	223
10/20/2	400,000	0	3091.69	129.38	54.58	50	135	16	607	39.68	37	102	12	498
10/30/2	600,000	0	3206.31	187.13	74.86	62	301	17	988	59.53	47	254	11	1236

Part 4 - Two Load Balanced Servers/DB Results

Part 4 - Output Window Results

10/10/2 Configuration

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=52048:/Applications/IntelliJ
IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
.m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
.0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
.0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
.m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
.m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
.m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
.m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
.m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
.jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
.m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 10 2 http://CS6650-app-lb-1902011158.us-west-2.elb.amazonaws.com/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - App Load Balancer - 2 Servlets, 1 DB --------
Thread Groups = 10, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 200000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 2899.01 (req/sec) ---> total successful requests / wall time
Wall Time: 68.99 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 31.21 (ms)
Median Response Time: 28 (ms)
p99 Response Time: 67 (ms)
Min Response Time: 17 (ms)
Max Response Time: 604 (ms)
-- GET Requests --
Mean Response Time: 19.97 (ms)
Median Response Time: 18 (ms)
p99 Response Time: 40 (ms)
Min Response Time: 12 (ms)
Max Response Time: 534 (ms)
-------- End of Results For Loading Java Server Phase - App Load Balancer - 2 Servlets, 1 DB --------
```

Image 7: Screenshot of output window for 10/10/2 run configuration.

10/20/2 Configuration

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=52237:/Applications/IntelliJ
 IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
 .m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
 .0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
 .0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
 .m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
 .m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
 .m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
 .m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
 .m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
 .jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
 .m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 20 2 http://CS6650-app-lb-1902011158.us-west-2.elb.amazonaws.com/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - App Load Balancer - 2 Servlets, 1 DB --------
Thread Groups = 20, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 400000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 4326.62 (req/sec) ---> total successful requests / wall time
Wall Time: 92.45 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 34.35 (ms)
Median Response Time: 31 (ms)
p99 Response Time: 93 (ms)
Min Response Time: 16 (ms)
Max Response Time: 478 (ms)
-- GET Requests --
Mean Response Time: 22.28 (ms)
Median Response Time: 19 (ms)
p99 Response Time: 64 (ms)
Min Response Time: 12 (ms)
Max Response Time: 323 (ms)
-------- End of Results For Loading Java Server Phase - App Load Balancer - 2 Servlets, 1 DB --------
```

Image 8: Screenshot of output window for 10/20/2 run configuration.

10/30/2 Configuration

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=52511:/Applications/IntelliJ
 IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
 .m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
 .0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
 .0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
 .m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
 .m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
 .m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
 .m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
 .m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
 .jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
 .m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 30 2 http://CS6650-app-lb-1902011158.us-west-2.elb.amazonaws.com/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - App Load Balancer - 2 Servlets, 1 DB --------
Thread Groups = 30, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 600000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 4943.52 (req/sec) ---> total successful requests / wall time
Wall Time: 121.37 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 40.2 (ms)
Median Response Time: 35 (ms)
p99 Response Time: 115 (ms)
Min Response Time: 16 (ms)
Max Response Time: 477 (ms)
-- GET Requests --
Mean Response Time: 27.63 (ms)
Median Response Time: 23 (ms)
p99 Response Time: 86 (ms)
Min Response Time: 12 (ms)
Max Response Time: 1099 (ms)
-------- End of Results For Loading Java Server Phase - App Load Balancer - 2 Servlets, 1 DB --------
```

Image 9: Screenshot of output window for 10/30/2 run configuration.

Part 4 - Table Results

Table 2: Results for Part 4 of Assignment 2

	Overall Results				POST Calculated Response Times (ms)					GET Calculated Response Times (ms)				
Configuration	# Successful Requests	# Failed Requests	Throughput (req/sec)	Wall Time (sec)	Mean	Median	p99	Min	Max	Mean	Median	p99	Min	Max
10/10/2	200,000	0	2899.01	68.99	31.21	28	67	17	604	19.97	18	40	12	534
10/20/2	400,000	0	4326.62	92.45	34.35	31	93	16	478	22.28	19	64	12	323
10/30/2	600,000	0	4943.52	121.37	40.2	35	115	16	477	27.63	23	86	12	1099

Part 5 - Optimized Server/DB Results - 10/30/2 Config

******* Read Before Continuing *******

It is highly important to make note of the following. Based on my internet upload speeds and the load we provide, calculations for my MAX theoretical throughput can be made.

- My average upload speed: 600 Mbps
- Upload speeds = 600 Mbps / 8 MBps = 75 MBps

- Size of image used: 3.475 KB
- Number of max POST requests sent with images: 300,000
- Total size uploaded = 3.475 KB * 300,000 images = 1,042,500 KB or 1,042.5 MB

- Assume ideal environment -> time to POST = 1,042 MB / 75 MBps = 13.9 seconds
- Time to POST with delay added = 13.9 seconds + 2 * 30 seconds = 73.9 seconds total

- Theoretical throughput = 300,000 requests / 73.9 seconds = 4,059.5 requests/sec

I bring this up because my theoretical throughput for **only** POSTs requests is already so high. They are what “throttle” my results, but 4000 req/sec is already very fast. Thus, it is very difficult to optimize these results. As seen below, optimization was attempted, but my optimized results plateaued and ranged between 4,800 and 5,400 req/sec.

If I scale up my resources further, I can achieve even better results. However, the free student trial account is limited and cannot scale past a certain point.

******* End *******

Before deciding how I wanted to optimize my results, I reviewed Monitoring logs provided by AWS. Below is a side-by-side of the CPU utilization my DB and Servlet 1 experienced in Parts 3 & 4. As seen in the images, there are four main peaks in each graph. The first three are the phase loads from Part 3, where only 1 Servlet was run across my DB. We can conclude that as the number of thread groups increased, the load experienced also did. The DB peaked at ~33%,

while Servlet at ~55%. The fourth peak represents phase tests from Part 4, running the application load balancer with two servlets. Since they were done in rapid succession, the peaks/metrics are blended. What is immediately noticed is that the CPU utilization for the servlet drastically dropped to ~27%. From this, I concluded to first scale up my DB.

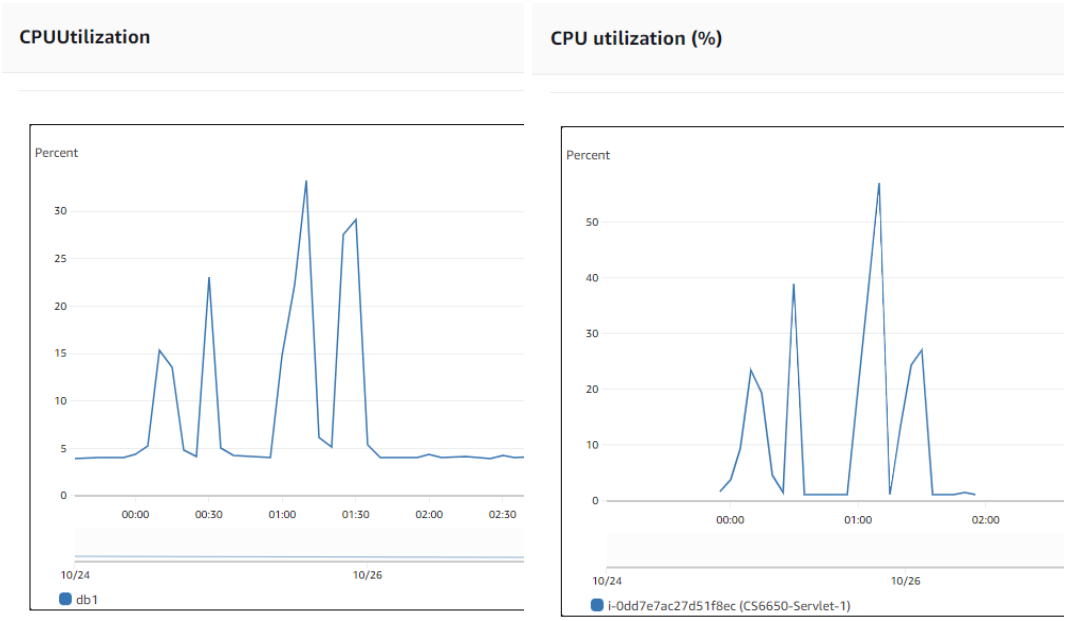


Image 10: CPU Utilization of DB and Servlet-1 for Parts 3 & 4.

NOTE: All prior tests had the following configurations: Servlet type - t2.micro; DB type - t3.micro with a CP size of 57.

Based on the results above, I made and tested multiple optimizations. Each time, I looked at the logs and adjusted what bottleneck my results. The changes were:

1. Scaled up DB -> Changed type: t3.micro -> t3.small
2. Scaled out Servlets -> Added Servlet to load balancer: 2 Servlets -> 3 Servlets
3. Scaled up DB -> Changed type: t3.small -> t3.medium
4. Scaled up Servlets -> Changed type: t2.micro -> t2.medium

With these changes, as I scaled up my DB, I increased my Hikari connection pool size and distributed it evenly across my servlets.

In total, I conducted five additional optimization tests. They each had the configurations seen in the table below.

Table 3: Configurations of optimization tests.

Configuration		
Run Parameters	Servlets	Database
10/30/2	2 - (t2.micro)	1 - t3.small (CP Size: 57)
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 57)
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 131)
10/30/2	3 - (t2.micro)	1 - t3.medium (CP Size: 225)
10/30/2	3 - (t2.medium)	1 - t3.medium (CP Size: 225)

From the optimization tests above, the CPU usage of my DB and Servlets was reasonable. In total, five peaks are seen. The second and third peaks appear as a plateau.

For my DB CPU usage, we see that as the DB is scaled up, the CPU usage is reduced under high load. When the type was increased to medium with 4x the amount of initial RAM, the CPU usage dropped ~11% to around 20%.

Further, regarding the servlet CPU usage, as the request distribution goes from 2 to 3 servlets, the CPU usage drops ~8% to about 25%.

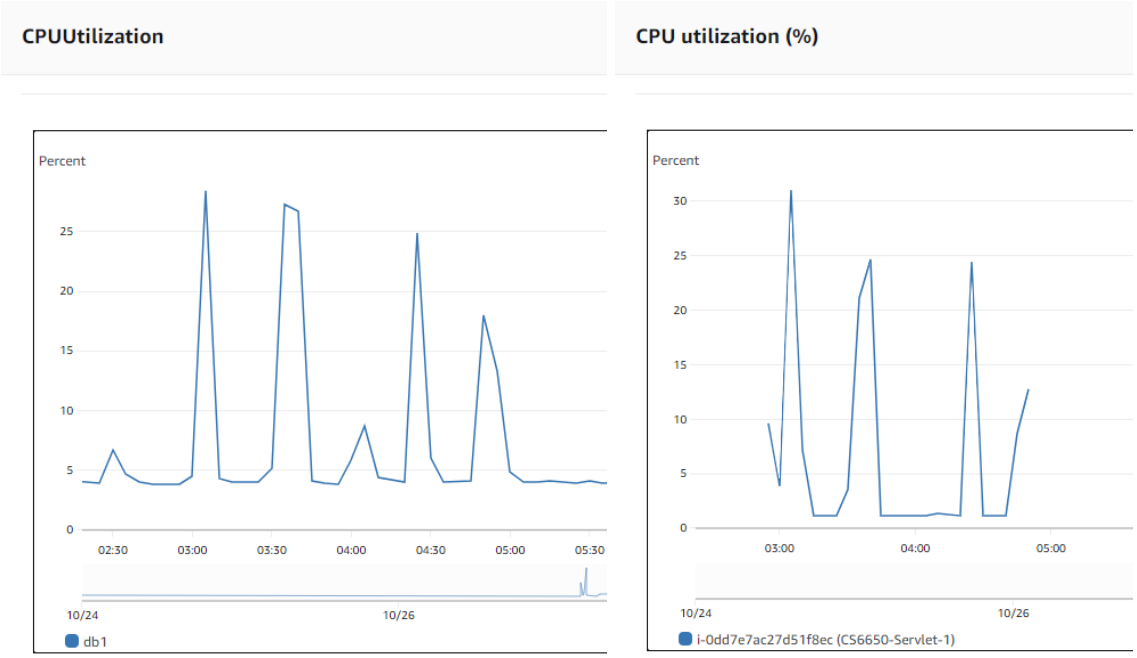


Image 11: CPU Utilization of DB and Servlet-1 for Part 5 optimizations.

From these optimizations, I achieved the following throughput % improvements.

Table 4: % Change in throughput across all 10/30/2 phase tests

Configurations - Run Parameters 10/30/2 - % Change Optimizations Caused				
Servlets	Database	Throughput (req/sec)	% Change From Part 3	% Change From Part 4
1 - (t2.micro)	1 - t3.micro (CP Size: 58)	3206.31	0	35.1% decrease
2 - (t2.micro)	1 - t3.micro (CP Size: 57)	4943.52	54.2% increase	0
2 - (t2.micro) - Part 5	1 - t3.small (CP Size: 57)	4816.03	50.2% increase	2.6% decrease
3 - (t2.micro) - Part 5	1 - t3.small (CP Size: 57)	5111.78	59.4% increase	3.4% increase
3 - (t2.micro) - Part 5	1 - t3.small (CP Size: 131)	4986.54	55.5% increase	0.9% increase
3 - (t2.micro) - Part 5	1 - t3.medium (CP Size: 225)	5310.44	65.6% increase	7.4% increase
3 - (t2.medium) - Part 5	1 - t3.medium (CP Size: 225)	5227.57	63.0% increase	5.7% increase

Part 5 - Output Window Results

2 Servlets (t2.micro) - 1 DB (t3.small - CP Size: 57)

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=54544:/Applications/IntelliJ
IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
.m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
.0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
.0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
.m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
.m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
.m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
.m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
.m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
.jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
.m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 30 2 http://CS6650-app-lb-1902011158.us-west-2.elb.amazonaws.com/Server_Web
-----------------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - App Load Balancer - 2 Servlets, 1 DB (db.t3.small) --------
Thread Groups = 30, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 600000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 4816.03 (req/sec) ---> total successful requests / wall time
Wall Time: 124.58 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 43.14 (ms)
Median Response Time: 40 (ms)
p99 Response Time: 94 (ms)
Min Response Time: 17 (ms)
Max Response Time: 343 (ms)
-- GET Requests --
Mean Response Time: 29.53 (ms)
Median Response Time: 26 (ms)
p99 Response Time: 73 (ms)
Min Response Time: 12 (ms)
Max Response Time: 273 (ms)
-------- End of Results For Loading Java Server Phase - App Load Balancer - 2 Servlets, 1 DB (db.t3.small) --------
```

Image 12: Output window for 2 Servlets (t2.micro) - 1 DB (t3.small - CP Size: 57) run.

3 Servlets (t2.micro) - 1 DB (t3.small - CP Size: 57)

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=55141:/Applications/IntelliJ
 IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
 .m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
 .0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
 .0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
 .m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
 .m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
 .m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
 .m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
 .m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
 .jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
 .m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 30 2 http://CS6650-app-lb-1902011158.us-west-2.elb.amazonaws.com/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - App Load Balancer - 3 Servlets, 1 DB (db.t3.small) --------
Thread Groups = 30, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 600000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 5111.78 (req/sec) ---> total successful requests / wall time
Wall Time: 117.38 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 37.3 (ms)
Median Response Time: 34 (ms)
p99 Response Time: 83 (ms)
Min Response Time: 16 (ms)
Max Response Time: 395 (ms)
-- GET Requests --
Mean Response Time: 24.73 (ms)
Median Response Time: 22 (ms)
p99 Response Time: 62 (ms)
Min Response Time: 12 (ms)
Max Response Time: 335 (ms)
-------- End of Results For Loading Java Server Phase - App Load Balancer - 3 Servlets, 1 DB (db.t3.small) --------
```

Image 13: Output window for 3 Servlets (t2.micro) - 1 DB (t3.small - CP Size: 57) run.

3 Servlets (t2.micro) - 1 DB (t3.small - CP Size: 141)

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=55584:/Applications/IntelliJ
 IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
 .m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
 .0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
 .0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
 .m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
 .m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
 .m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
 .m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
 .m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
 .jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
 .m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 30 2 http://CS6650-app-lb-1902011158.us-west-2.elb.amazonaws.com/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - App Load Balancer - 3 Servlets, 1 DB (db.t3.small, 141 Connections) --------
Thread Groups = 30, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 600000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 4986.54 (req/sec) ---> total successful requests / wall time
Wall Time: 120.32 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 42.77 (ms)
Median Response Time: 39 (ms)
p99 Response Time: 116 (ms)
Min Response Time: 16 (ms)
Max Response Time: 359 (ms)
-- GET Requests --
Mean Response Time: 24.61 (ms)
Median Response Time: 22 (ms)
p99 Response Time: 61 (ms)
Min Response Time: 12 (ms)
Max Response Time: 329 (ms)
-------- End of Results For Loading Java Server Phase - App Load Balancer - 3 Servlets, 1 DB (db.t3.small, 141 Connections) --------
```

Image 14: Output window for 3 Servlets (t2.micro) - 1 DB (t3.small - CP Size: 141) run.

3 Servlets (t2.micro) - 1 DB (t3.medium - CP Size: 225)

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=56384:/Applications/IntelliJ
IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
.m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0.
0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6.
0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
.m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
.m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
.m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
.m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
.m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
.jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
.m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 30 2 http://CS6650-app-lb-1902011158.us-west-2.elb.amazonaws.com/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - App Load Balancer - 3 Servlets, 1 DB (db.t3.medium, 225 Connections) --------
Thread Groups = 30, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 600000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 5310.44 (req/sec) ---> total successful requests / wall time
Wall Time: 112.98 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 38.79 (ms)
Median Response Time: 35 (ms)
p99 Response Time: 98 (ms)
Min Response Time: 17 (ms)
Max Response Time: 558 (ms)
-- GET Requests --
Mean Response Time: 20.9 (ms)
Median Response Time: 19 (ms)
p99 Response Time: 46 (ms)
Min Response Time: 12 (ms)
Max Response Time: 536 (ms)
-------- End of Results For Loading Java Server Phase - App Load Balancer - 3 Servlets, 1 DB (db.t3.medium, 225 Connections) --------
```

Image 15: Output window for 3 Servlets (t2.micro) - 1 DB (t3.medium - CP Size: 225) run.

3 Servlets (t2.medium) - 1 DB (t3.medium - CP Size: 225)

```
/Library/Java/JavaVirtualMachines/jdk-17.0.4.1.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA.app/Contents/lib/idea_rt.jar=56947:/Applications/IntelliJ
IDEA.app/Contents/bin -Dfile.encoding=UTF-8 -classpath /Users/tsanevp/Documents/CS6650/CS6650-Assignment2/Client/target/classes:/Users/tsanevp/
.m2/repository/io/swagger/swagger-java-client/1.0.0/swagger-java-client-1.0.0.jar:/Users/tsanevp/.m2/repository/io/swagger/core/v3/swagger-annotations/2.0
.0/swagger-annotations-2.0.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/okhttp/2.7.5/okhttp-2.7.5.jar:/Users/tsanevp/.m2/repository/com/squareup/okio/okio/1.6
.0/okio-1.6.0.jar:/Users/tsanevp/.m2/repository/com/squareup/okhttp/logging-interceptor/2.7.5/logging-interceptor-2.7.5.jar:/Users/tsanevp/
.m2/repository/com/google/code/gson/gson/2.8.1/gson-2.8.1.jar:/Users/tsanevp/.m2/repository/io/gsonfire/gson-fire/1.8.3/gson-fire-1.8.3.jar:/Users/tsanevp/
.m2/repository/org/threeten/threetenbp/1.3.5/threetenbp-1.3.5.jar:/Users/tsanevp/.m2/repository/javax/annotation/jsr250-api/1.0/jsr250-api-1.0.jar:/Users/tsanevp/
.m2/repository/org/jetbrains/annotations/24.0.1/annotations-24.0.1.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi/3.9/poi-3.9.jar:/Users/tsanevp/
.m2/repository/commons-codec/commons-codec/1.5/commons-codec-1.5.jar:/Users/tsanevp/.m2/repository/org/apache/poi/poi-ooxml/3.9/poi-ooxml-3.9.jar:/Users/tsanevp/
.m2/repository/org/apache/poi/poi-ooxml-schemas/3.9/poi-ooxml-schemas-3.9.jar:/Users/tsanevp/.m2/repository/org/apache/xmlbeans/xmlbeans/2.3.0/xmlbeans-2.3.0
.jar:/Users/tsanevp/.m2/repository/stax/stax-api/1.0.1/stax-api-1.0.1.jar:/Users/tsanevp/.m2/repository/dom4j/dom4j/1.6.1/dom4j-1.6.1.jar:/Users/tsanevp/
.m2/repository/xml-apis/xml-apis/1.0.b2/xml-apis-1.0.b2.jar Part2.AlbumClient 10 30 2 http://CS6650-app-lb-1902011158.us-west-2.elb.amazonaws.com/Server_Web
--------------------------------------------------------------------------------
-------- Printing Results For Loading Java Server Phase - App Load Balancer - 3 Servlets (t2.medium), 1 DB (db.t3.medium, 225 Connections) --------
Thread Groups = 30, Number of Threads per Group = 10, Call per Thread = 1000
Number of Successful Requests: 600000
Number of Failed Requests: 0

-------- Results --------
---- Throughput's & Wall Time ----
Throughput: 5227.57 (req/sec) ---> total successful requests / wall time
Wall Time: 114.78 (sec)

---- Calculations ----
-- POST Requests --
Mean Response Time: 38.36 (ms)
Median Response Time: 35 (ms)
p99 Response Time: 102 (ms)
Min Response Time: 17 (ms)
Max Response Time: 434 (ms)
-- GET Requests --
Mean Response Time: 20.96 (ms)
Median Response Time: 19 (ms)
p99 Response Time: 42 (ms)
Min Response Time: 11 (ms)
Max Response Time: 256 (ms)
-------- End of Results For Loading Java Server Phase - App Load Balancer - 3 Servlets (t2.medium), 1 DB (db.t3.medium, 225 Connections) --------
```

Image 16: Output window for 3 Servlets (t2.medium) - 1 DB (t3.medium - CP Size: 225) run.

Part 5 - Table Results

Table 5: Measured Results for Part 5 of Assignment 2

Configuration			Measured Results			
Run Parameters	Servlets	Database	# Successful Requests	# Failed Requests	Throughput (req/sec)	Wall Time (sec)
10/30/2	2 - (t2.micro)	1 - t3.small (CP Size: 57)	600,000	0	4816.03	124.58
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 57)	600,000	0	5111.78	117.38
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 131)	600,000	0	4986.54	120.32
10/30/2	3 - (t2.micro)	1 - t3.medium (CP Size: 225)	600,000	0	5310.44	112.98
10/30/2	3 - (t2.medium)	1 - t3.medium (CP Size: 225)	600,000	0	5227.57	114.78

Table 6: POST Calculated Results for Part 5 of Assignment 2

Configuration			POST Calculated Response Times (ms)				
Run Parameters	Servlets	Database	Mean	Median	p99	Min	Max
10/30/2	2 - (t2.micro)	1 - t3.small (CP Size: 57)	43.14	40	94	17	343
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 57)	37.3	34	83	16	395
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 131)	42.77	39	116	16	359
10/30/2	3 - (t2.micro)	1 - t3.medium (CP Size: 225)	38.79	35	98	17	558
10/30/2	3 - (t2.medium)	1 - t3.medium (CP Size: 225)	38.36	35	102	17	434

Table 7: GET Calculated Results for Part 5 of Assignment 2

Configuration			GET Calculated Response Times (ms)				
Run Parameters	Servlets	Database	Mean	Median	p99	Min	Max
10/30/2	2 - (t2.micro)	1 - t3.small (CP Size: 57)	29.53	26	73	12	273
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 57)	24.73	22	62	12	335
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 131)	24.61	22	61	12	329
10/30/2	3 - (t2.micro)	1 - t3.medium (CP Size: 225)	20.9	19	46	12	536
10/30/2	3 - (t2.medium)	1 - t3.medium (CP Size: 225)	20.96	19	42	11	256

Part 5 - Server/DB Results Comparison

Table 8: Measured Results for Part 5 of Assignment 2

Configuration			Measured Results			
Run Parameters	Servlets	Database	# Successful Requests	# Failed Requests	Throughput (req/sec)	Wall Time (sec)
10/10/2 - Part 3	1 - (t2.micro)	1 - t3.micro (CP Size: 58)	200,000	0	2675.26	74.76
10/20/2 - Part 3	1 - (t2.micro)	1 - t3.micro (CP Size: 58)	400,000	0	3091.69	129.38
10/30/2 - Part 3	**1 - (t2.micro)**	**1 - t3.micro (CP Size: 58)**	600,000	0	**3206.31**	**187.13**
10/10/2 - Part 4	2 - (t2.micro)	1 - t3.micro (CP Size: 57)	200,000	0	2899.01	68.99
10/20/2 - Part 4	2 - (t2.micro)	1 - t3.micro (CP Size: 57)	400,000	0	4326.62	92.45
10/30/2 - Part 4	**2 - (t2.micro)**	**1 - t3.micro (CP Size: 57)**	600,000	0	**4943.52**	**121.37**
10/30/2 - Part 5	2 - (t2.micro)	1 - t3.small (CP Size: 57)	600,000	0	4816.03	124.58
10/30/2 - Part 5	3 - (t2.micro)	1 - t3.small (CP Size: 57)	600,000	0	5111.78	117.38
10/30/2 - Part 5	3 - (t2.micro)	1 - t3.small (CP Size: 131)	600,000	0	4986.54	120.32
10/30/2 - Part 5	**3 - (t2.micro)**	**1 - t3.medium (CP Size: 225)**	600,000	0	**5310.44**	**112.98**
10/30/2 - Part 5	3 - (t2.medium)	1 - t3.medium (CP Size: 225)	600,000	0	5227.57	114.78

Table 9: POST Calculated Results for Part 5 of Assignment 2

Configuration			POST Calculated Response Times (ms)				
Run Parameters	Servlets	Database	Mean	Median	p99	Min	Max
10/10/2 - Part 3	1 - (t2.micro)	1 - t3.micro (CP Size: 58)	35.65	33	77	16	302
10/20/2 - Part 3	1 - (t2.micro)	1 - t3.micro (CP Size: 58)	54.58	50	135	16	607
10/30/2 - Part 3	1 - (t2.micro)	1 - t3.micro (CP Size: 58)	74.86	62	301	17	988
10/10/2 - Part 4	2 - (t2.micro)	1 - t3.micro (CP Size: 57)	31.21	28	67	17	604
10/20/2 - Part 4	2 - (t2.micro)	1 - t3.micro (CP Size: 57)	34.35	31	93	16	478
10/30/2 - Part 4	2 - (t2.micro)	1 - t3.micro (CP Size: 57)	40.2	35	115	16	477
10/30/2	2 - (t2.micro)	1 - t3.small (CP Size: 57)	43.14	40	94	17	343
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 57)	37.3	34	83	16	395
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 131)	42.77	39	116	16	359
10/30/2	3 - (t2.micro)	1 - t3.medium (CP Size: 225)	38.79	35	98	17	558
10/30/2	3 - (t2.medium)	1 - t3.medium (CP Size: 225)	38.36	35	102	17	434

Table 10: GET Calculated Results for Part 5 of Assignment 2

Configuration			GET Calculated Response Times (ms)				
Run Parameters	Servlets	Database	Mean	Median	p99	Min	Max
10/10/2 - Part 3	1 - (t2.micro)	1 - t3.micro (CP Size: 58)	22.12	20	50	12	223
10/20/2 - Part 3	1 - (t2.micro)	1 - t3.micro (CP Size: 58)	39.68	37	102	12	498
10/30/2 - Part 3	1 - (t2.micro)	1 - t3.micro (CP Size: 58)	59.53	47	254	11	1236
10/10/2 - Part 4	2 - (t2.micro)	1 - t3.micro (CP Size: 57)	19.97	18	40	12	534
10/20/2 - Part 4	2 - (t2.micro)	1 - t3.micro (CP Size: 57)	22.28	19	64	12	323
10/30/2 - Part 4	2 - (t2.micro)	1 - t3.micro (CP Size: 57)	27.63	23	86	12	1099
10/30/2	2 - (t2.micro)	1 - t3.small (CP Size: 57)	29.53	26	73	12	273
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 57)	24.73	22	62	12	335
10/30/2	3 - (t2.micro)	1 - t3.small (CP Size: 131)	24.61	22	61	12	329
10/30/2	3 - (t2.micro)	1 - t3.medium (CP Size: 225)	20.9	19	46	12	536
10/30/2	3 - (t2.medium)	1 - t3.medium (CP Size: 225)	20.96	19	42	11	256

Supplemental Screenshots

ALB & Target Groups

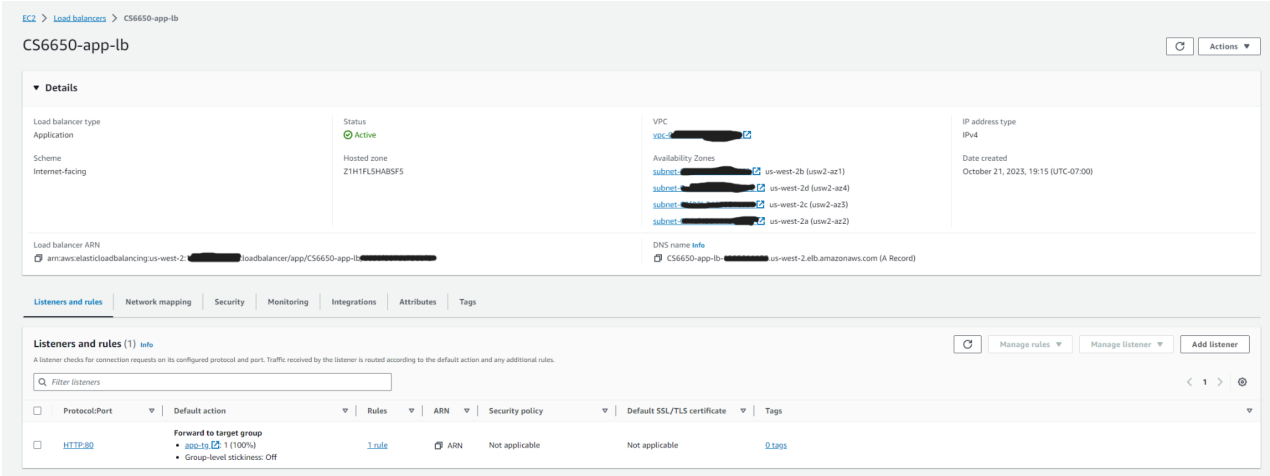


Image 17: My Application Load Balancer configuration.

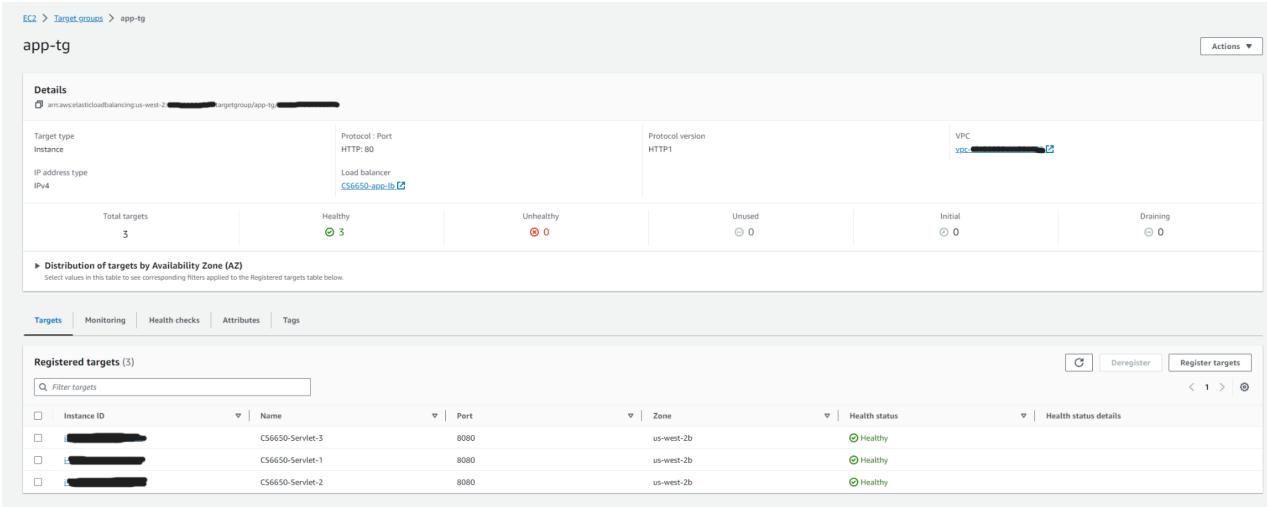
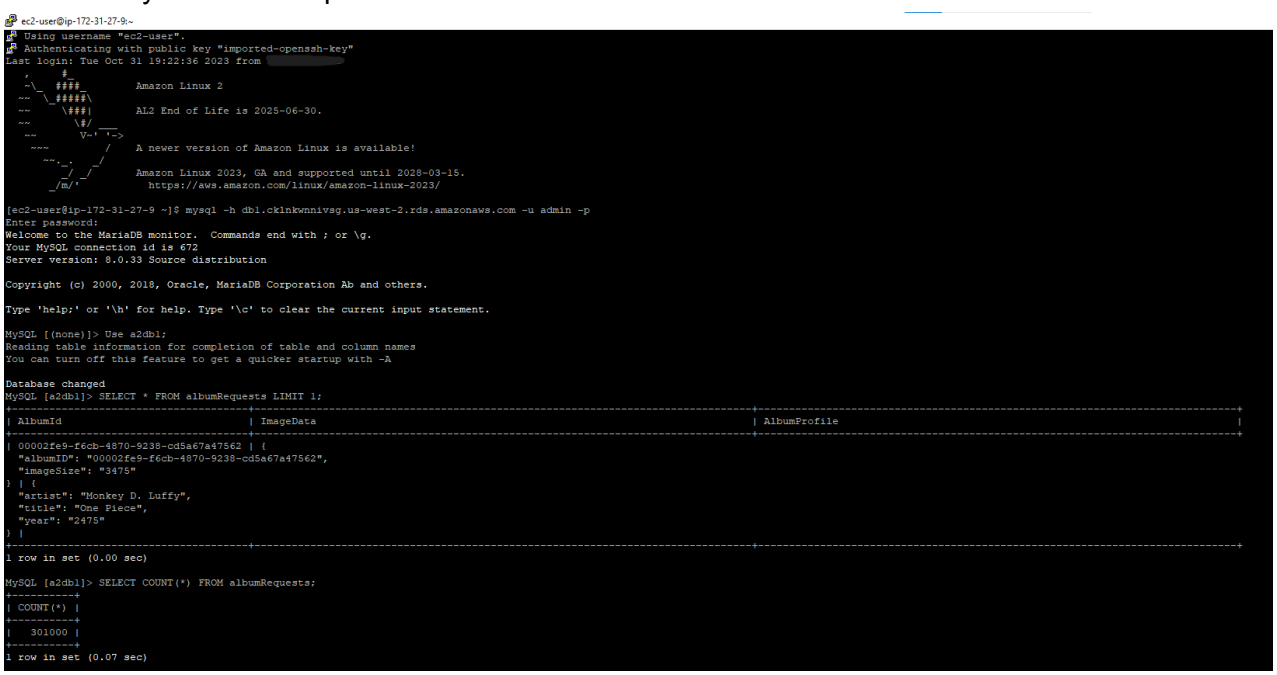


Image 18: My target group configuration for my three servlets.

DB After Testing

Below, I have included a screenshot of my DB after performing a 10/30/2 phase test. As seen, the DB now contains 301,000 entries, with the first entry printed. The additional 1,000 entries are from my initialization phase.



```
ec2-user@ip-172-31-27-9:~
Using username "ec2-user".
Authenticating with public key "imported-openssh-key"
Last login: Tue Oct 31 19:22:36 2023 from
       #_
   ~\_  ####_        Amazon Linux 2
  ~~  \_#####\
  ~~     \###|       AL2 End of Life is 2025-06-30.
  ~~       \#/ ___
   ~~       V~' '->
    ~~~         /    A newer version of Amazon Linux is available!
      ~~._.   _/
         _/ _/       Amazon Linux 2023, GA and supported until 2028-03-15.
       _/m/'           https://aws.amazon.com/linux/amazon-linux-2023/

[ec2-user@ip-172-31-27-9 ~]$ mysql -h db1.cklnkwnnivsg.us-west-2.rds.amazonaws.com -u admin -p
Enter password:
Welcome to the MariaDB monitor.  Commands end with ; or \g.
Your MySQL connection id is 672
Server version: 8.0.33 Source distribution

Copyright (c) 2000, 2018, Oracle, MariaDB Corporation Ab and others.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

MySQL [(none)]> Use a2db1;
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Database changed
MySQL [a2db1]> SELECT * FROM albumRequests LIMIT 1;
+--------------------------------------+--------------------------------------------------------------------------------+--------------------------------------------------------------------------------+
| AlbumId                              | ImageData                                                                      | AlbumProfile                                                                   |
+--------------------------------------+--------------------------------------------------------------------------------+--------------------------------------------------------------------------------+
| 00002fe9-f6cb-4870-9238-cd5a67a47562 | {
  "albumID": "00002fe9-f6cb-4870-9238-cd5a67a47562",
  "imageSize": "3475"
} | {
  "artist": "Monkey D. Luffy",
  "title": "One Piece",
  "year": "2475"
} |
+--------------------------------------+--------------------------------------------------------------------------------+--------------------------------------------------------------------------------+
1 row in set (0.00 sec)

MySQL [a2db1]> SELECT COUNT(*) FROM albumRequests;
+----------+
| COUNT(*) |
+----------+
|   301000 |
+----------+
1 row in set (0.07 sec)
```

Image 19: MySQL DB after the 10/30/2 phase test.

After each test, I cleared my DB and deleted all entries. This helped keep the DB size relatively small and consistent across all tests. Further, deleting entries after each test reduced the data the DB had to process during writes and queries. The assignment did not specify this was not allowed, and since it helped reduce latencies across requests, I took advantage of it.

I could never connect to MySQL DB locally using MySQL Workbench or DBeaver. After ensuring my security groups allowed traffic to my IP and my DB was publicly accessible, I resorted to connecting to my DB using the CLI.

CPU Utilization For DB/EC2 Instances Across All Tests

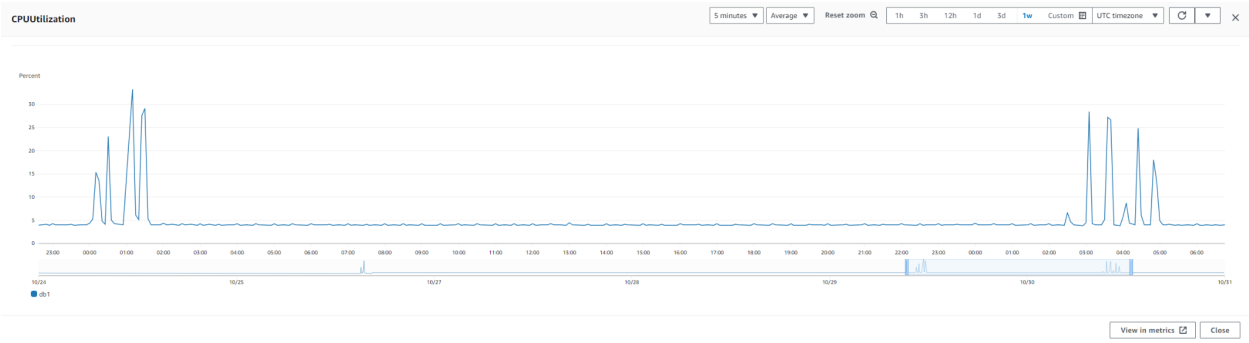


Image 20: MySQL DB CPU utilization across all phase tests.

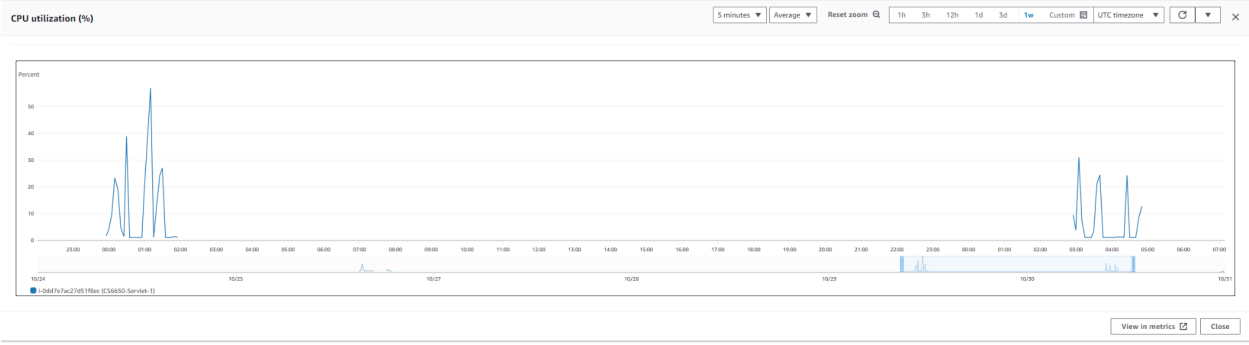


Image 21: MySQL Servlet 1 CPU utilization across all phase tests.

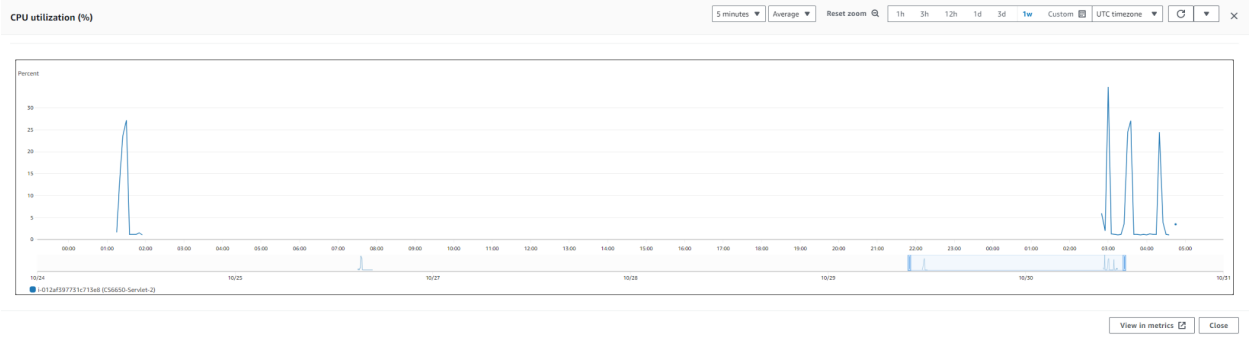


Image 20: MySQL Servlet 2 CPU utilization across all phase tests.

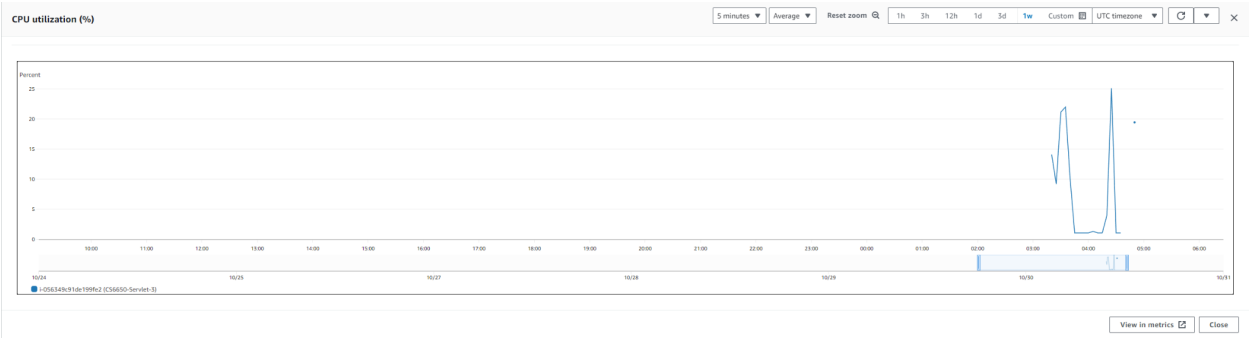


Image 20: MySQL Servlet 3 CPU utilization across all phase tests.