



# ASSIGNMENT II

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Link To assignment:

<https://gortonator.github.io/bsds-6650/assignments-2021/Assignment-2>

Code Repository:

<https://github.com/xelese/BSDS/tree/master/Assignment2>

No changes in the client were made. Made use of <https://github.com/gortonator/bsds-6650/blob/master/assignments-2021/bsds-summer-2021-testdata-assignment2.txt> this text file for Load testing containing almost 100,000 lines. Client was run locally.

The diagram illustrates the architecture of a Java application, organized into three main packages: Controller, Model, and General.

**Controller Package:**

- Client:** Contains a `main()` method.
- CliController:** Contains `CliController()` and `run()` methods.

**Model Package:**

- Consumer:** Contains attributes `apiInstance : TextbodyApi`, `body : TextLine`, `function : String`, and `queue : BlockingQueue<String>`. Methods include `Consumer()` and `run()`.
- Producer:** Contains attributes `debugLineCounter : Integer` and `scanner : Scanner`. Methods include `Producer()`, `getDebugLineCounter()`, and `run()`.
- DataBuffer:** Contains attributes `failCounter : AtomicInteger`, `loggingDataList : List<LoggingData>`, `producerComplete : AtomicInteger`, `queue : BlockingQueue<String>`, `successCounter : AtomicInteger`, and `textLineCounter : AtomicInteger`. Methods include `DataBuffer()`, `getFailCounter()`, `getLoggingDataList()`, `getProducerComplete()`, `getQueue()`, `getSuccessCounter()`, and `getTextLineCounter()`.
- LoggingData:** Contains attributes `latency : Integer`, `requestType : String`, `responseCode : Integer`, and `startTime : String`. Methods include `LoggingData()`, `compareTo()`, `getLatency()`, `getRequestType()`, `getResponseCode()`, and `getStartTime()`.

**General Package:**

- CustomLogger:** Contains methods `CalculateResponse()`, `CustomLogger()`, and `writeLogData()`.
- Config:** Contains attributes `baseUriPath : String`, `consumerThreads : Integer`, `logFile : File`, `inputFile : File`, `producerThreads : Integer`, and `queueSize : Integer`. Methods include `Config()`, `getBaseUriPath()`, `getConsumerThreads()`, `getLogFile()`, `getMyFile()`, `getProducerThreads()`, and `getQueueSize()`.

**Relationships:**

- Generalization:** `Runnable` and `Comparable` (from `java.lang`) are generalized by `Consumer` and `Producer` respectively.
- Aggregation:** `Consumer` and `Producer` are aggregated by `DataBuffer` (indicated by hollow diamond symbols).
- Association:** `CustomLogger` is associated with `Config` (labeled `config`) and `DataBuffer` (labeled `dataBuffer`).
- Association:** `Config` is associated with `DataBuffer` (labeled `dataBuffer`).

## Server Description:

A few changes were made to the server. Firstly, the previous spring boot implementation has been scrapped in favor of Http servlet.

The performance improvement form HTTP servlet was better in comparison to Spring Boot system. On an average if the benchmark for 256 threads was considered at 2500 req/s for Assignment 1, with the wordcount function and RabbitMQ implementation.

- a. The Spring boot implementation was showing 1700 req/s at most.
- b. The Http servlets was better with about 2300 req/s at minimum.

With some optimization I was able to get the performance equal to Assignment 1 or better.

In the GIT repository you would notice that there are 2 Server implementations. Server and Server2. I have used Server for my final presentation. Server2 is Spring boot test which was considerably slow.

One important note here is regarding RabbitMQ and channel creation. I am currently using Apache Pools2 implementation to create a pool. There were many considerations for different pool sizes for channels. I tested the application with a min of 128 channels maintained with a maximum of 256 channels. In my testing I found out that Tomcat allows you to create only up to 200 channels to RabbitMQ per server.

One small optimization was by creating a local hash map of the request and sending the toString() value of that to the Consumer. That allowed me to return to the client faster and have a better throughput in general.

The server has been created on AWS in two configurations:

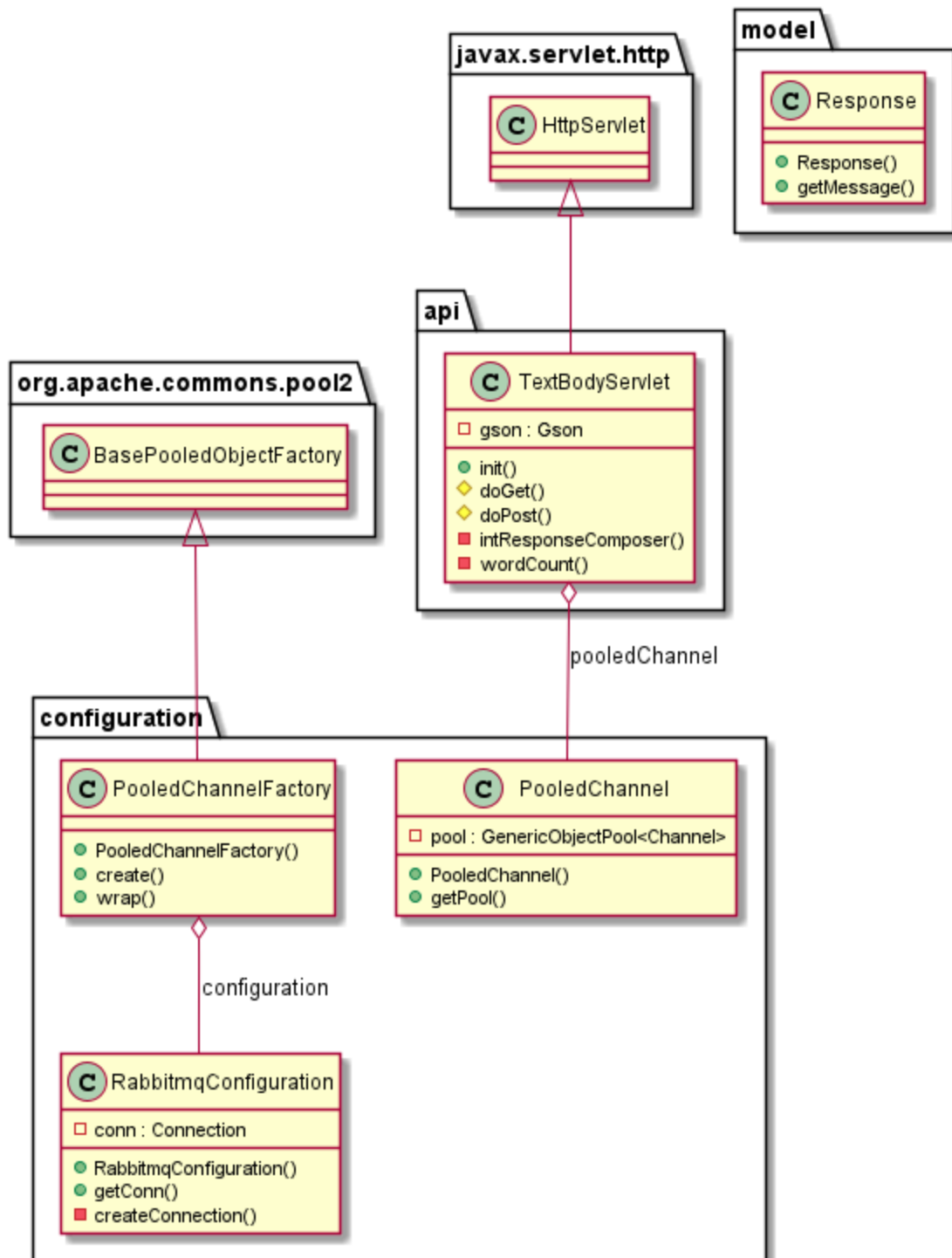
Firstly, a single instance.

- Amazon Linux 2
- T2 Micro
- Tomcat 8.5
- US-EAST-1 (N. Virginia)

Secondly, load balanced via Elastic Beanstalk instance.

- Amazon Linux 2
- T2 Micro
- Tomcat 8.5
- US-EAST-1 (N. Virginia)
- 4 instances.

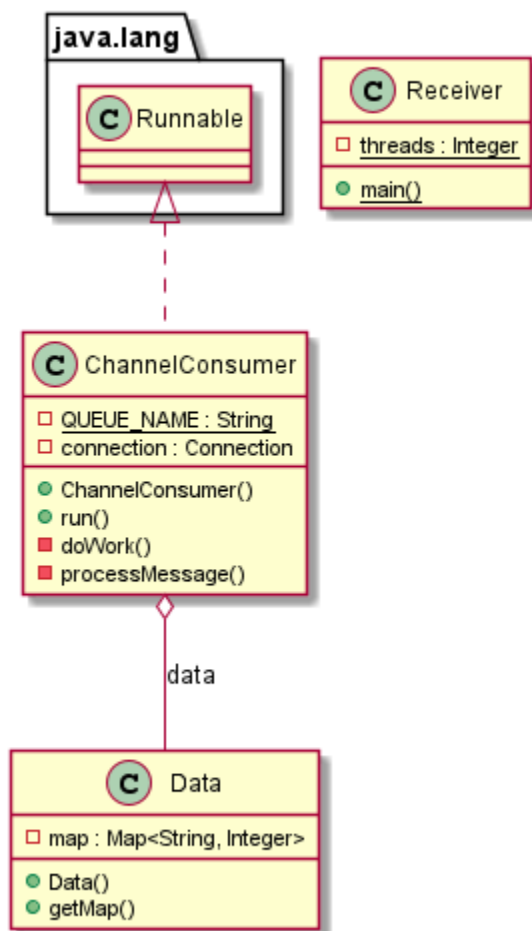
## HTTP Servlet Class Diagram



## Consumer Description:

The consumer is quite simple, it establishes a connection with RabbitMQ and runs pulls data via `basicAck()` and processes messages into a concurrent hash map. The data here needs to be deconstructed by the consumer before it can be added to the map. In my testing I found 256 threads for the consumer to be ideal number where the consumption always kept up with the client's production. Even at 512 client Threads. One more interesting note is that a new channel was created per thread instead of borrowing it from any pool.

### Consumer Class Diagram



## RabbitMQ Description:

RabbitMQ was hosted on an EC2 instance with the following configuration.

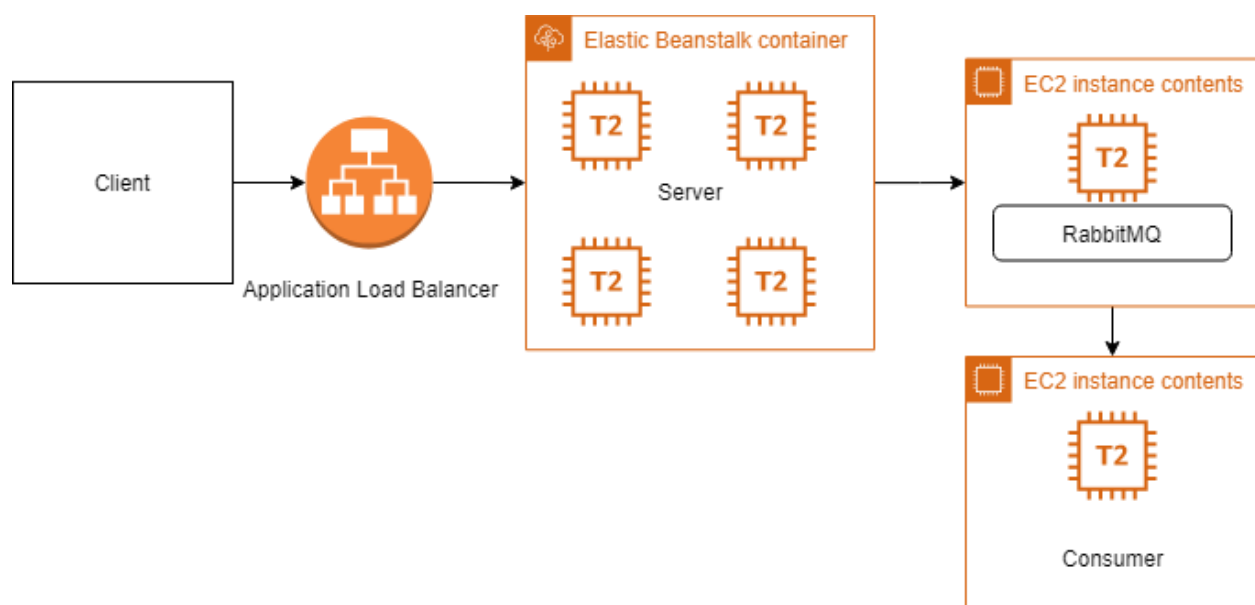
- Amazon Linux 2
- T2 Micro
- US-EAST-1 (N. Virginia)
- Elastic IP

Initial impression was to use a T2 Small as it would have a larger ram size however, it appears that with enough T2 Micro is enough to handle this load if the consumption keeps up with the production rate.

I had also assigned an elastic IP to RabbitMQ so that the server and consumer code did not have to be updated every time I stopped the instance.

## Overall System Design:

Client connects to an application load balancer which routes the data to one of the instances of server running within the Elastic Beanstalk. Once processed the data is sent to RabbitMQ which is running on a separate EC2 instance with an Elastic IP attached to it. RabbitMQ then pushes the data to Consumer as the Consumer is subscribed to RabbitMQ running on a separate EC2 instance.



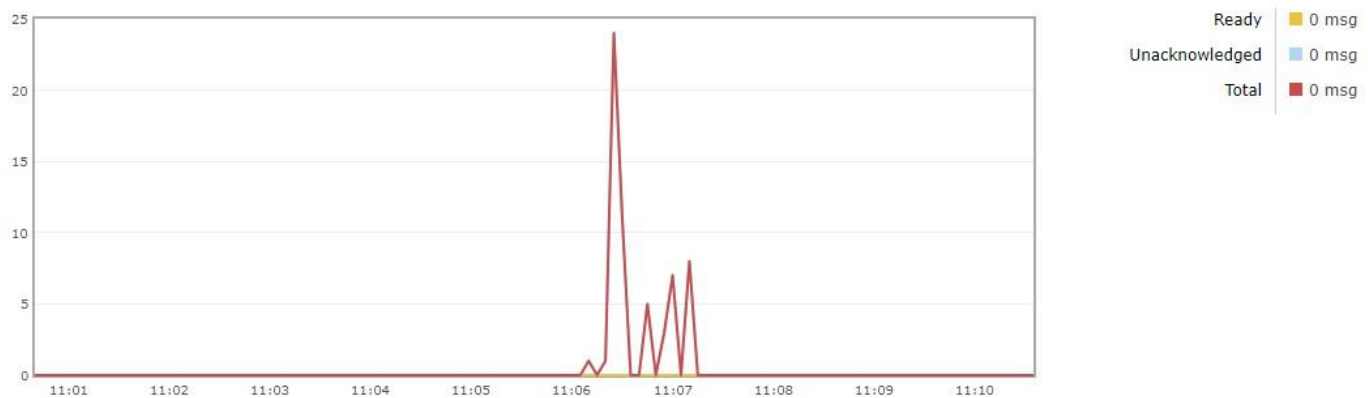
## Results:

32 Threads:

No Load Balancer:

```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 32
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-17-12-31-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 80.79355 s
4. Throughput: 1229.0585 req/s
----- DETAILED STATS -----
1. Mean Response Time: 25.517038 ms
1. Median Response Time: 26.5 ms
1. Max Response Time: 23.0 ms
1. 90th Percentile: 25.0 ms
-----
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)



32 Threads:

Load Balancer:

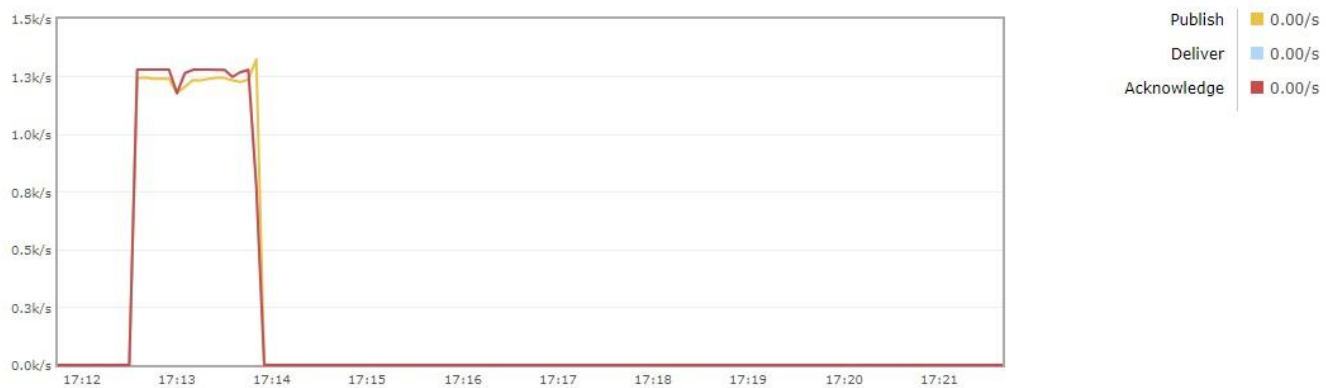
```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 32
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-11-06-00-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 79.48894 s
4. Throughput: 1249.2305 req/s
----- DETAILED STATS -----
1. Mean Response Time: 25.09004 ms
1. Median Response Time: 24.0 ms
1. Max Response Time: 34.0 ms
1. 90th Percentile: 22.0 ms
-----

Process finished with exit code 0
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)





64 Threads:

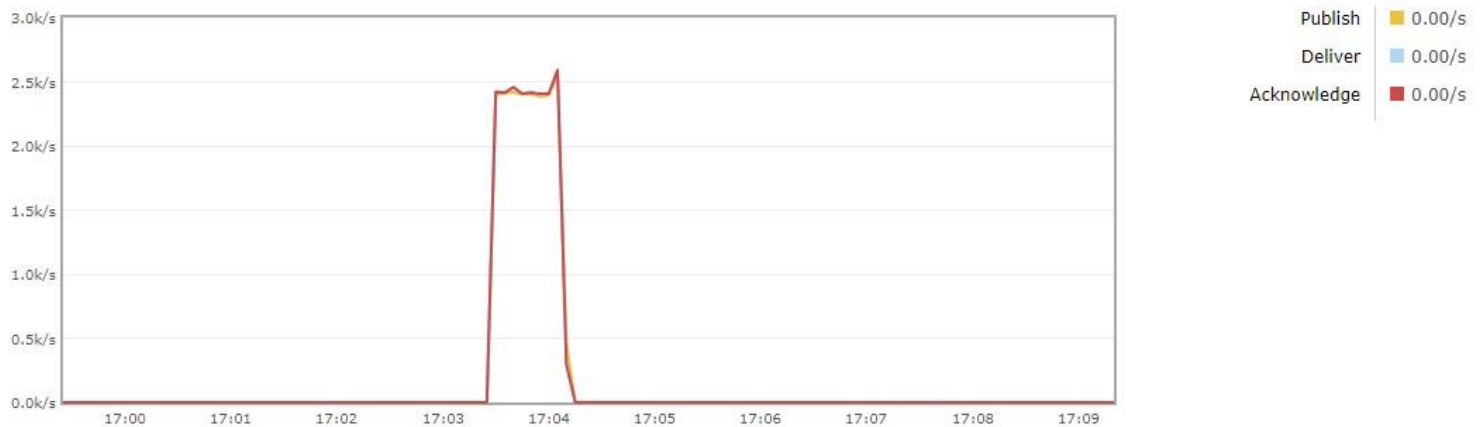
No Load Balancer:

```
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 64
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-17-03-27-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 41.727192 s
4. Throughput: 2379.7432 req/s
----- DETAILED STATS -----
1. Mean Response Time: 26.356375 ms
1. Median Response Time: 28.5 ms
1. Max Response Time: 30.0 ms
1. 90th Percentile: 29.0 ms
-----
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)

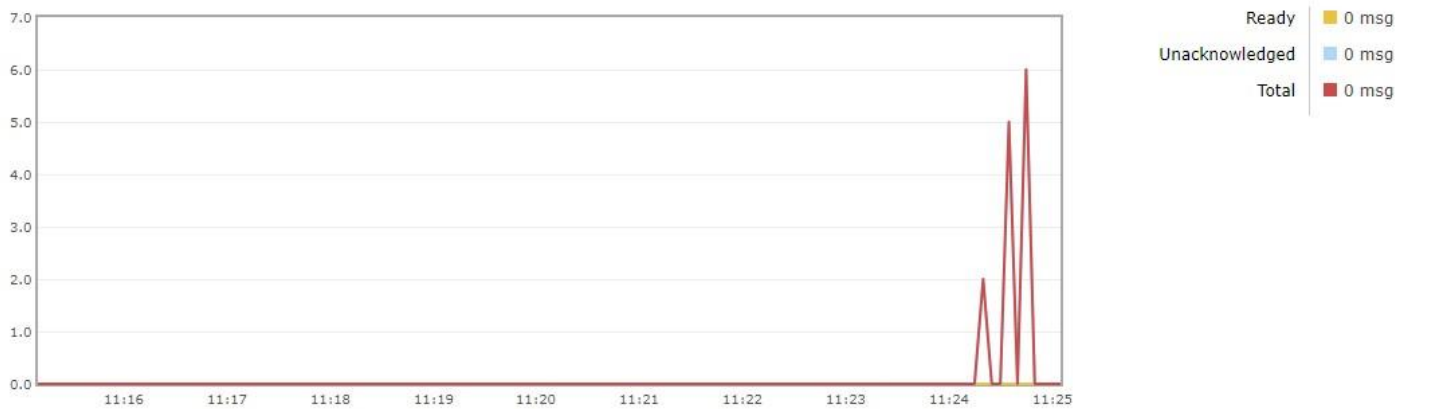


64 Threads:

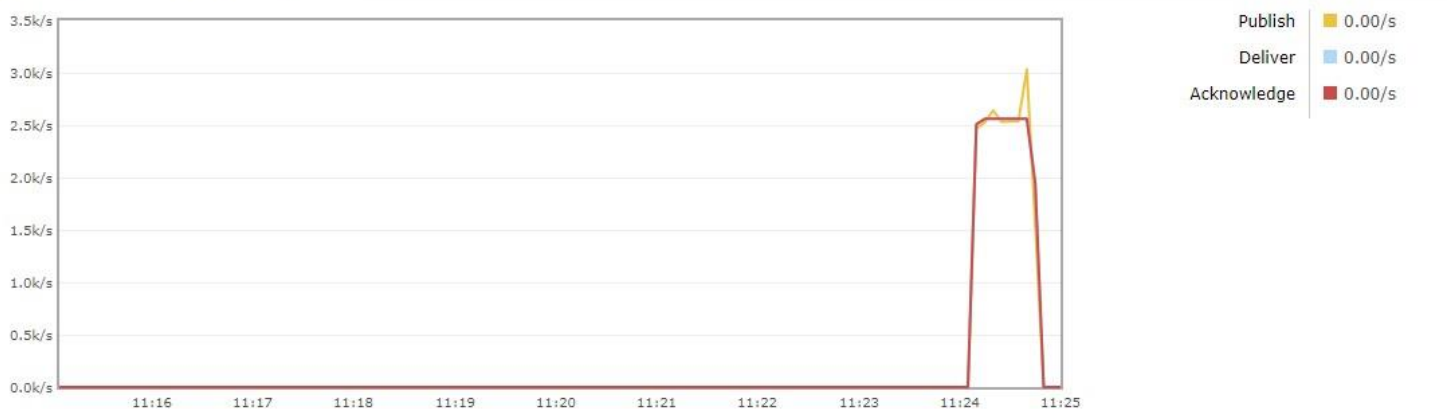
Load Balancer:

```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 64
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-11-24-08-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 39.702724 s
4. Throughput: 2501.088 req/s
----- DETAILED STATS -----
1. Mean Response Time: 25.045881 ms
1. Median Response Time: 23.5 ms
1. Max Response Time: 33.0 ms
1. 90th Percentile: 23.0 ms
-----
Process finished with exit code 0
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)



128 Threads:

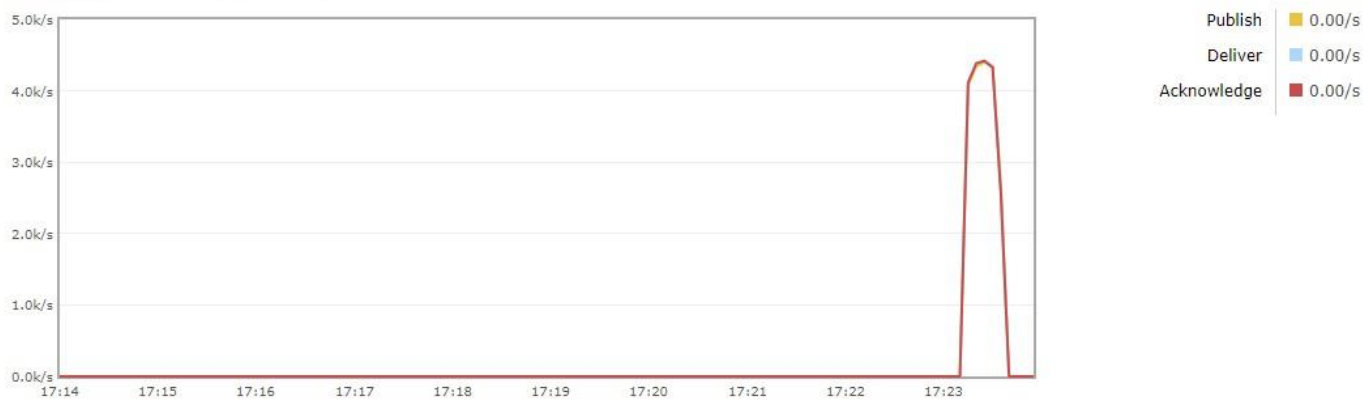
No Load Balancer:

```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 128
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-17-23-13-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 23.519615 s
4. Throughput: 4222.008 req/s
----- DETAILED STATS -----
1. Mean Response Time: 29.718933 ms
1. Median Response Time: 30.5 ms
1. Max Response Time: 28.0 ms
1. 90th Percentile: 31.0 ms
-----
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)

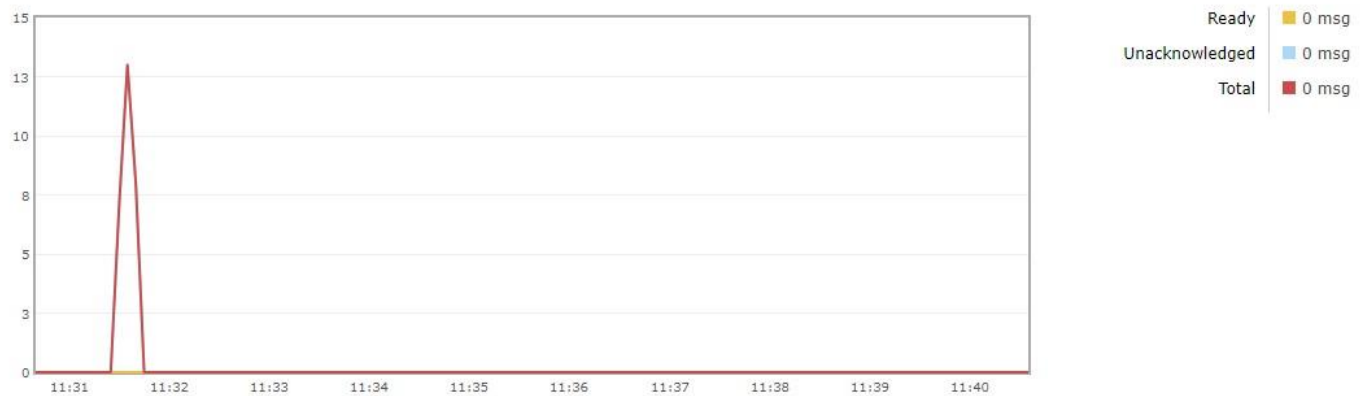


128 Threads:

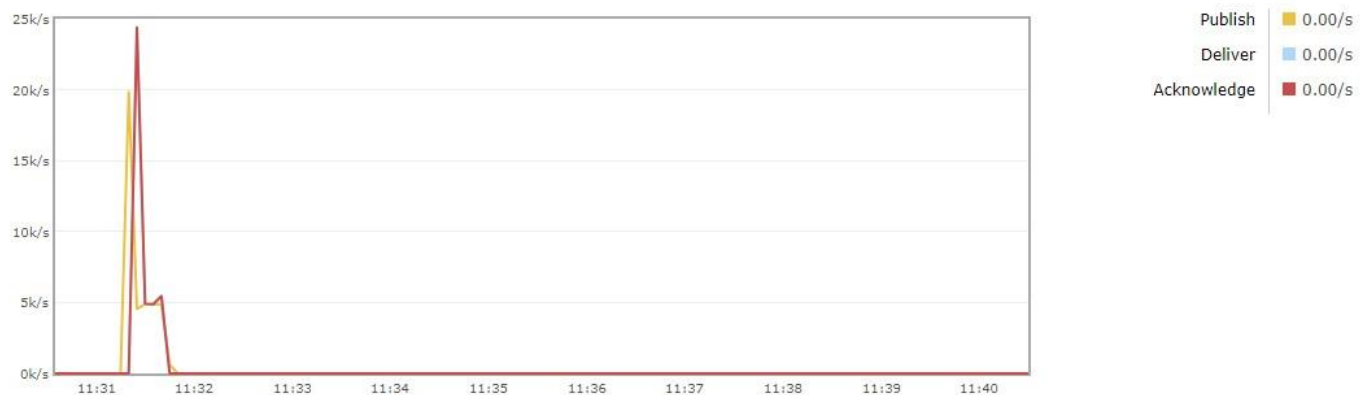
Load Balancer:

```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 128
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-11-31-21-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 21.129494 s
4. Throughput: 4699.592 req/s
----- DETAILED STATS -----
1. Mean Response Time: 26.565428 ms
1. Median Response Time: 25.5 ms
1. Max Response Time: 98.0 ms
1. 90th Percentile: 28.0 ms
-----
Process finished with exit code 0
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)

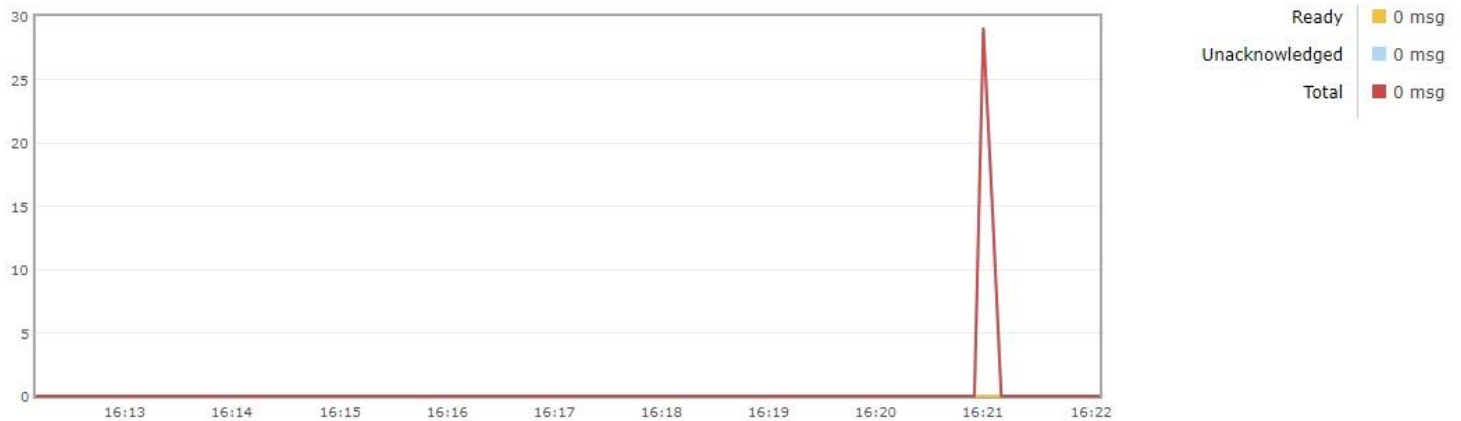


256 Threads:

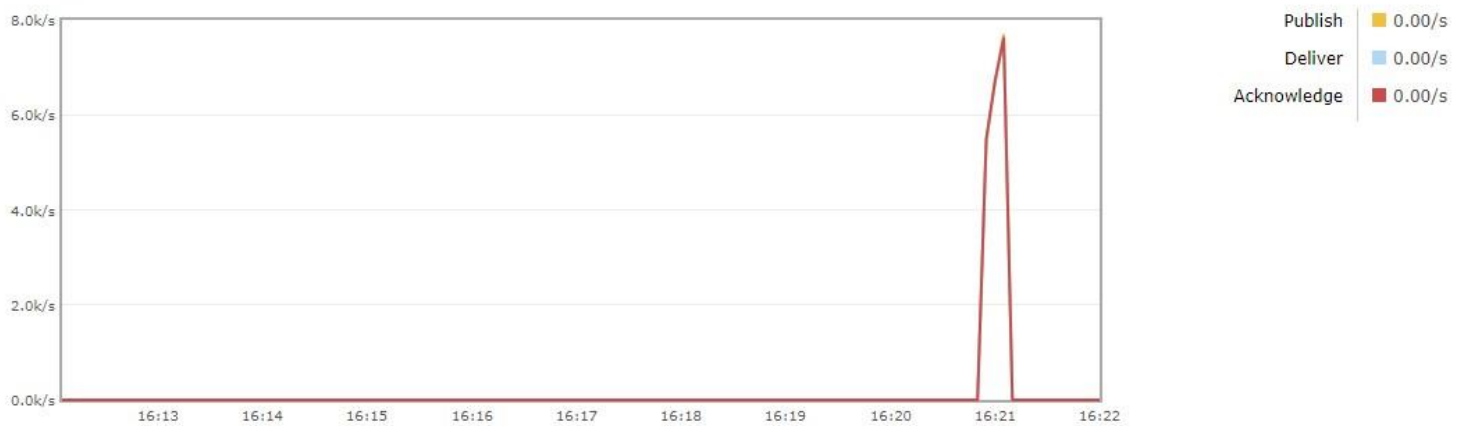
No Load Balancer:

```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 256
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-16-08-08-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 16.04369 s
4. Throughput: 6189.349 req/s
----- DETAILED STATS -----
1. Mean Response Time: 39.89813 ms
1. Median Response Time: 37.5 ms
1. Max Response Time: 32.0 ms
1. 90th Percentile: 39.0 ms
-----
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)

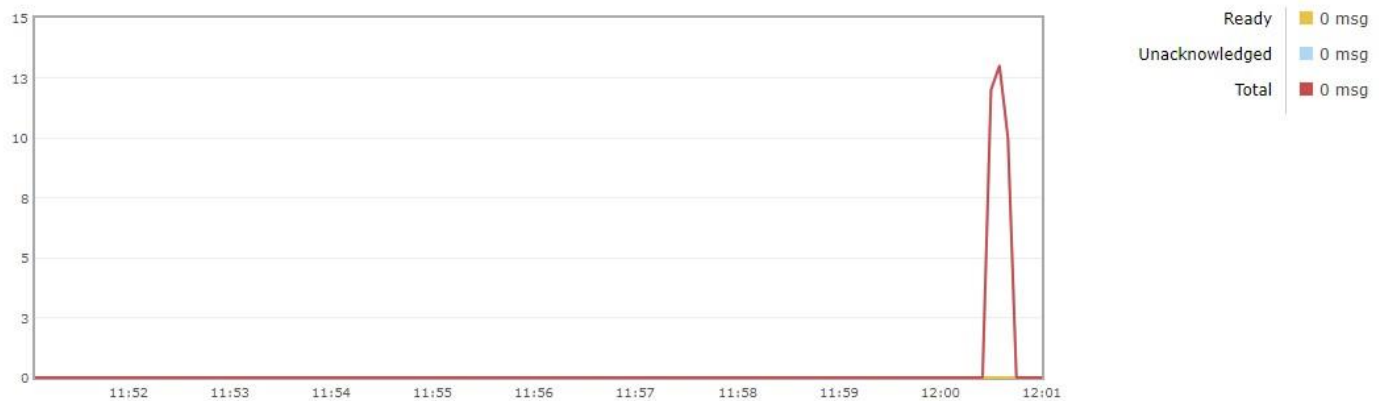


256 Threads:

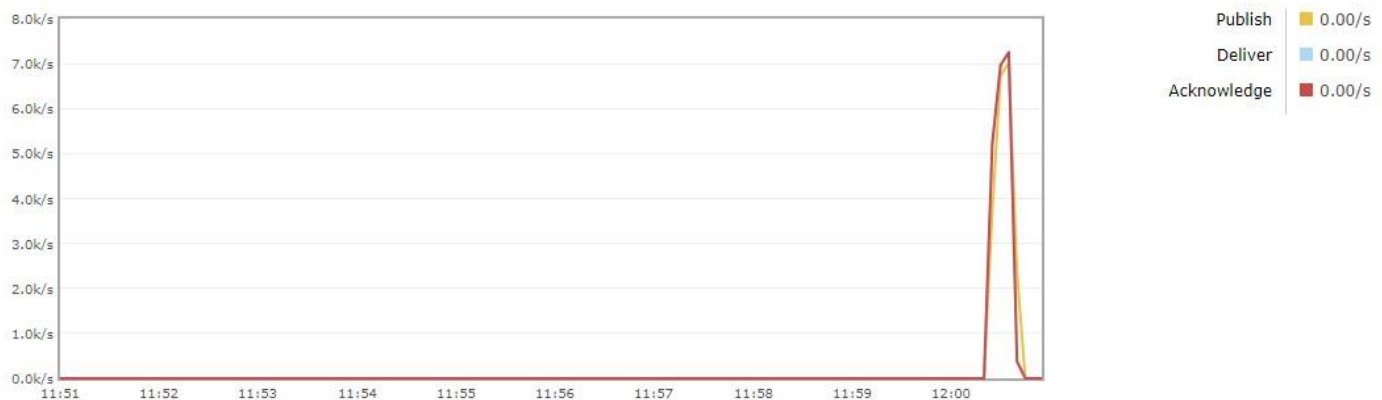
Load Balancer:

```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 256
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-12-00-22-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 15.907543 s
4. Throughput: 6242.322 req/s
----- DETAILED STATS -----
1. Mean Response Time: 36.85151 ms
1. Median Response Time: 28.5 ms
1. Max Response Time: 79.0 ms
1. 90th Percentile: 31.0 ms
-----
Process finished with exit code 0
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)



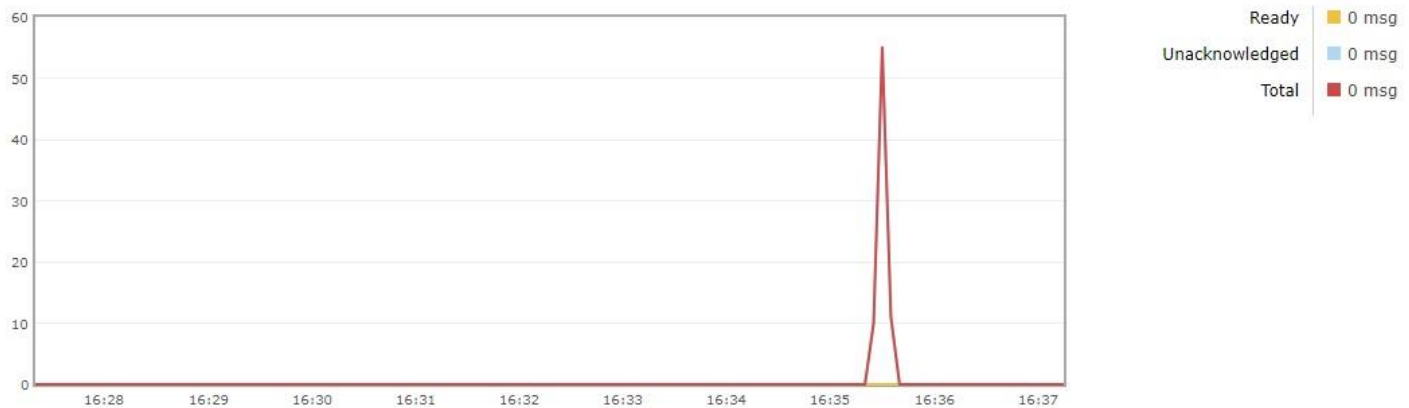


512 Threads:

No Load Balancer:

```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 512
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-16-35-18-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 16.508469 s
4. Throughput: 6015.0947 req/s
----- DETAILED STATS -----
1. Mean Response Time: 74.247734 ms
1. Median Response Time: 59.5 ms
1. Max Response Time: 553.0 ms
1. 90th Percentile: 120.0 ms
-----
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)



512 Threads:

Load Balancer:

```
All threads terminated.
----- CONFIG -----
Total number of producer Threads: 1
Total number of consumer Threads: 512
Total number of client requests consumed: 99300
Log File location: .\log\2021-06-14-12-42-12-log.csv
----- OVERALL STATS -----
1. Total number of successful requests sent: 99300
2. Total number of unsuccessful requests sent: 0
3. Total wall time: 16.055292 s
4. Throughput: 6184.8765 req/s
----- DETAILED STATS -----
1. Mean Response Time: 72.46346 ms
1. Median Response Time: 128.0 ms
1. Max Response Time: 100.0 ms
1. 90th Percentile: 96.0 ms
-----
```

Queued messages (chart: last ten minutes) (?)



Message rates (chart: last ten minutes) (?)





## Conclusion:

It appears that the load balanced system was only slightly faster than the single instance in returning output to the client, However it brings additional stability to the system by making the server highly available and allowing more requests overall.