

# 6650 Assignment 2

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URL: <https://github.com/tjuqxb/6650-assignment2>

## Main Classes In Server

**ResortServlet:** This class handles the requests to /resorts/\* route. It is responsible for validating the paths and parameters. It also checks the format of JSON POST.

**SkierServlet:** This class handles the requests to /skiers/\* route. It is responsible for validating the paths and parameters. It also checks the format of JSON POST. In init(), it also creates a connection to RabbitMQ and initializes a channel pool.

**StatisticsServlet:** This class handles the requests to /statistics/\* route. It is responsible for validating the paths and parameters.

**Utils:** This class contains static common utility functions.

**SkierPost:** This class can be mapped to a standard POST JSON object specified by the skier API.

**ResortPost:** This class can be mapped to a standard POST JSON object specified by the resort API.

## Packages

**domain:** This package is used to store classes which can be mapped to standard POST JSON objects specified by the API. It currently contains two class: SkierPost and ResortPost.

## Messages Send and Receive

**Send:** In SkierServlet: in init() method, a connection is set up at the initial stage. A BlockingQueue is utilized as the thread safe container of the Channel pool. 200 Channels are created and added to the BlockingQueue. In doPost() method, if the JSON string is valid, the program would encode the skier ID and the JSON string together as String message. Then it would be blocked and apply for a Channel object from the BlockingQueue until it gets one available Channel. After setting up some parameters, the encoded message would be sent to the Channel. Then the Channel would be returned to the BlockingQueue.

**Receive:** The user would input the number of consumer threads to the main entry point in ConsumerService. Then in main() method the program would put the same number of threads to the thread pool. Every single Consumer thread would own its own Channel and keep consuming messages from the Channel. Every message Object would be in a Vector and every Vector is associated with a skier ID in a ConcurrentMap. Those two data structures are thread safe in multi-thread programming.

## Results and analysis

### Analysis on throughput:

I run the loading tests from local laptop. The loading tests run 64, 128, 256, 512 client

threads to exert load on 1 instance, 2 instances and 4 instances (t2 micro instance).

There are some analyses:

1. It can be seen that it is necessary to scale out when we have large number of client threads ( $\geq 256$ ). We don't need to scale out when the number of client threads is small. Although it might also increase throughput a bit with small number of clients, the cost is too high in comparison to the benefits.
2. For one instance throughput, if the number of base client threads is large, then it is more likely to reach the throughput limit in each phase. This explains the small difference between 256 threads and 512 threads on one instance throughput.
3. It can be seen that for 64 threads and 128 threads, one EC2 t2 micro instance is enough. For 256 threads, we might need two t2 micro instances for better performance. For 512 threads, we might need four t2 micro instances.
4. RabbitMQ limit is its memory. A free tier's memory might not be enough for large throughput. I use t2.medium for larger memory.
5. I also run loading test application on an EC2 instance from another availability zone in the same region. 64 threads throughput would increase rapidly with a greater number of instances. We can deduce that the latency is quite low when testing from an EC2 instance in the same region.

**Throughputs (screenshots for 4 instances are attached):**

For 64 threads: 1 instance: 481; 2 instances: 481; 4 instances: 531

For 128 threads: 1 instance: 751; 2 instances: 792; 4 instances: 821

For 256 threads: 1 instance: 881; 2 instances: 1436; 4 instances: 1503

For 512 threads: 1 instance: 987; 2 instances: 1533; 4 instances: 2013

**Analysis on number of consumer threads:**

One consumer thread can handle about 1.5k/s incoming rate. After testing, if we need to handle 4k to 6k incoming rates and keep the queue short, we might need more than 50 consumer threads.

## Queues

All queues (1)

Pagination

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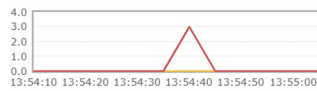
Overview				Messages			Message rates			+/-
Name	Type	Features	State	Ready	Unacked	Total	incoming	deliver / get	ack	
threadExQ	classic	<span>D</span>	<span>running</span>	0	0	0	1,036/s	1,043/s	1,043/s	

Add a new queue

## Overview

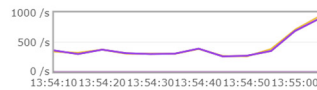
Totals

Queued messages last minute ?



Ready 0  
Unacked 25  
Total 25

Message rates last minute ?



Publish 933/s  
Publisher confirm 0.00/s  
Deliver (manual ack) 894/s  
Deliver (auto ack) 0.00/s  
Consumer ack 894/s  
Redelivered 0.00/s  
Get (manual ack) 0.00/s  
Get (auto ack) 0.00/s  
Get (empty) 0.00/s  
Unroutable (return) 0.00/s  
Unroutable (drop) 0.00/s  
Disk read 0.00/s  
Disk write 0.00/s

Global counts ?

Connections: 5 Channels: 825 Exchanges: 7 Queues: 1 Consumers: 25

```

<?xml version="1.0" encoding="UTF-8"?>
<parameters>
  <numThreads>64</numThreads>
  <numSkiers>28800</numSkiers>
  <numLifts>48</numLifts>
  <numRuns>18</numRuns>
  <InetAddressAndPort>http://Assignment-LB-6658-v2-c712e2af1c73ec74.elb.us-west-2.amazonaws.com/LAB2_2_war</InetAddressAndPort>
</parameters>
  
```

```

Run: ClientService
Phase 2 starts!
Phase 3 starts!
number of success requests: 188888
number of failed requests: 0
wall time: 338367
throughput: 531
mean response time: 53.7 milliseconds
median response time: 46.0 milliseconds
P99 response time: 175 milliseconds
min response time: 18 milliseconds
max response time: 4033 milliseconds
Process finished with exit code 0
  
```

64 threads 4 instances

## Queues

▼ All queues (1)

Pagination

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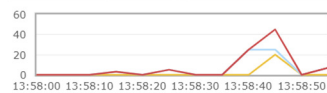
Overview				Messages			Message rates			+/-
Name	Type	Features	State	Ready	Unacked	Total	incoming	deliver / get	ack	
threadExQ	classic	<span style="color: blue;">D</span>	<span style="color: green;">■</span> running	0	0	0	1,419/s	1,412/s	1,413/s	

► Add a new queue

## Overview

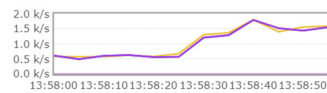
▼ Totals

Queued messages last minute ?



Ready ■ 0  
Unacked ■ 15  
Total ■ 15

Message rates last minute ?



Publish ■ 1,585/s  
Publisher confirm ■ 0.00/s  
Deliver (manual ack) ■ 1,551/s  
Deliver (auto ack) ■ 0.00/s  
Consumer ack ■ 1,552/s  
Redelivered ■ 0.00/s  
Get (manual ack) ■ 0.00/s  
Get (auto ack) ■ 0.00/s  
Get (empty) ■ 0.00/s  
Unroutable (return) ■ 0.00/s  
Unroutable (drop) ■ 0.00/s  
Disk read ■ 0.00/s  
Disk write ■ 0.00/s

Global counts ?

Connections: 5 Channels: 825 Exchanges: 7 Queues: 1 Consumers: 25

```

1 <?xml version="1.0" encoding="UTF-8"?>
2 <parameters>
3   <numThreads>128</numThreads>
4   <numSkiers>20000</numSkiers>
5   <numLifts>40</numLifts>
6   <numRuns>10</numRuns>
7   <InetAddressAndPort>http://Assignment-L8-6658-v2-c712e2af1c73ec74.elb.us-west-2.amazonaws.com/LAB2_2_war</InetAddressAndPort>
8 </parameters>

```

```

Run: ClientService
  "D:\Program Files\Java\jdk-11.0.14\bin\java.exe" ...
  number of threads: 128
  Phase 1 starts!
  Phase 2 starts!
  Phase 3 starts!
  number of success requests: 100000
  number of failed requests: 0
  wall time: 219016
  throughput: 821
  mean response time: 82.8 milliseconds
  median response time: 72.0 milliseconds
  P99 response time: 253 milliseconds
  min response time: 18 milliseconds
  max response time: 5343 milliseconds
  Process finished with exit code 0

```

128 threads 4 instances

## Queues

▼ All queues (1)

Pagination

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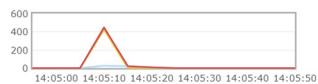
Overview				Messages			Message rates			+/-
Name	Type	Features	State	Ready	Unacked	Total	incoming	deliver / get	ack	
threadExQ	classic	<span style="color: blue;">D</span>	<span style="color: green;">running</span>	0	6	6	1,152/s	1,550/s	1,550/s	

► Add a new queue

## Overview

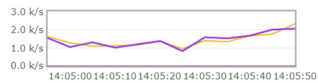
▼ Totals

Queued messages last minute ?



Ready 0  
Unacked 9  
Total 9

Message rates last minute ?



Publish 2,312/s  
Publisher confirm 0.00/s  
Deliver (manual ack) 2,048/s  
Deliver (auto ack) 0.00/s  
Consumer ack 2,048/s  
Redelivered 0.00/s  
Get (manual ack) 0.00/s  
Get (auto ack) 0.00/s  
Get (empty) 0.00/s  
Unroutable (return) 0.00/s  
Unroutable (drop) 0.00/s  
Disk read 0.00/s  
Disk write 0.00/s

Global counts ?

Connections: 5 Channels: 825 Exchanges: 7 Queues: 1 Consumers: 25

```

<?xml version="1.0" encoding="UTF-8"?>
<parameters>
  <numThreads>256</numThreads>
  <numSkiers>28808</numSkiers>
  <numLifts>48</numLifts>
  <numRuns>18</numRuns>
  <InetAddrAndPort>http://TEST3-82be10ad174fc4de.elb.us-west-2.amazonaws.com/LAB2_2_war/InetAddrAndPort</InetAddrAndPort>
</parameters>
  
```

```

Run: ClientService
"D:\Program Files\Java\jdk-11.0.14\bin\java.exe" ...
number of threads: 256
Phase 1 starts!
Phase 2 starts!
Phase 3 starts!
number of success requests: 100000
number of failed requests: 0
wall time: 119711
throughput: 1503
mean response time: 92.4 milliseconds
median response time: 68.0 milliseconds
P99 response time: 359 milliseconds
min response time: 17 milliseconds
max response time: 5825 milliseconds
Process finished with exit code 0
  
```

256 threads 4 instances

## Queues

▼ All queues (1)

Pagination

Page  of 1 - Filter:  ☐ Regex ?

Overview				Messages			Message rates			+/-
Name	Type	Features	State	Ready	Unacked	Total	incoming	deliver / get	ack	
threadExQ	classic		running	0	0	0	1,657/s	1,454/s	1,454/s	

► Add a new queue

## Overview

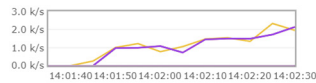
▼ Totals

Queued messages last minute ?



Ready 32  
Unacked 25  
Total 57

Message rates last minute ?



Publish 1,947/s  
Publisher confirm 0.00/s  
Deliver (manual ack) 2,140/s  
Deliver (auto ack) 0.00/s  
Consumer ack 2,140/s  
Redelivered 0.00/s  
Get (manual ack) 0.00/s  
Get (auto ack) 0.00/s  
Get (empty) 0.00/s  
Unroutable (return) 0.00/s  
Unroutable (drop) 0.00/s  
Disk read 0.00/s  
Disk write 0.00/s

Global counts ?

Connections: 5 Channels: 825 Exchanges: 7 Queues: 1 Consumers: 25

```

<?xml version="1.0" encoding="UTF-8"?>
<parameters>
  <numThreads>512</numThreads>
  <numSkiers>20000</numSkiers>
  <numLifts>4</numLifts>
  <numRuns>10</numRuns>
  <InetAddrAndPort>http://TEST3-82be18ad174fc4de.elb.us-west-2.amazonaws.com/LAB2_2_war</InetAddrAndPort>
</parameters>
  
```

```

Run: ClientService
"D:\Program Files\Java\jdk-11.0.14\bin\java.exe" ...
number of threads: 512
Phase 1 starts!
Phase 2 starts!
Phase 3 starts!
number of success requests: 100000
number of failed requests: 0
wall time: 89415
throughput: 2013
mean response time: 178.6 milliseconds
median response time: 134.8 milliseconds
P99 response time: 1021 milliseconds
min response time: 17 milliseconds
max response time: 8196 milliseconds
Process finished with exit code 0
  
```

512 threads 4 instances