Testing Document

SWEN90007

Music Events System

Team: GGBond

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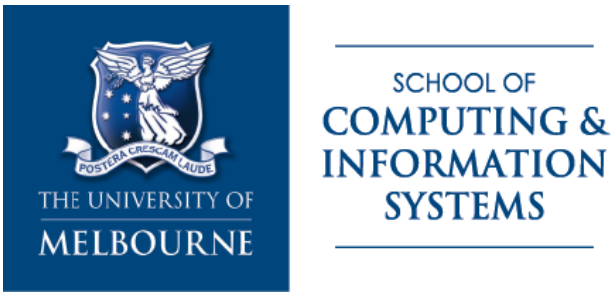


Revision History

Date	Version	Description	Author
21/9/2022	03.00-D01	Initial draft	Linjing Bi Jie Zhou Baorui Chen Liuming Teng
27/9/2022	03.00-D02	Added draft concurrency issues	Linjing Bi
28/9/2022	03.00-D03	Adjusted draft concurrency issues	Jie Zhou
05/10/2022	03.00-D04	Added draft of concurrency patterns	Baorui Chen
09/10/2022	03.00-D05	Draft of pattern implementations	Jie Zhou Baorui Chen
11/10/2022	03.00-D06	Refined concurrency patterns	Linjing Bi
12/10/2022	03.00-D07	Refined issue descriptions	Linjing Bi Jie Zhou Baorui Chen
13/10/2022	03.00-D08	Added test results	Linjing Bi Liuming Teng
14/10/2022	03.00-D09	Added class diagram	Linjing Bi
15/10/2022	03.00-D10	Added sequence diagrams	Jie Zhou Baorui Chen
17/10/2022	03.00-D11	Finalised test results	Linjing Bi Jie Zhou Baorui Chen Liuming Teng
17/10/2022	03.00-D12	Added appendix	Linjing Bi Jie Zhou Baorui Chen Liuming Teng
17/10/2022	03.00-D13	Finalised document content	Linjing Bi Jie Zhou Baorui Chen Liuming Teng

Contents

1. Introduction

1.1 Proposal

The purpose of this document is to define and present the test cases for project Music Event System and GGBond, covering the test cases for the system use cases.

1.2 Target Users

This document in mainly designed for those responsible for executing the test cases in this project [team members and SWEN90007 teaching team].

1.3 Conventions, terms and abbreviations

This section explains the concept of some important terms that will be used throughout this document. These terms are described in the following table, presented in alphabetical order.

Term	Description
Redis	Redis is an open-source, in-memory data storage system that is highly suitable for handling high concurrency and low-latency applications.
Booking Confirmation	A digital or electronic receipt provided to the user upon successful reservation of tickets for a music event.

2. Class Diagram

Given the intricacy of system-wide class diagrams, we've segmented the entire system into several class diagrams, each organized by package. This approach is designed to methodically present the relationships between classes and layers within the Music Event System.

2.1 Component Diagram

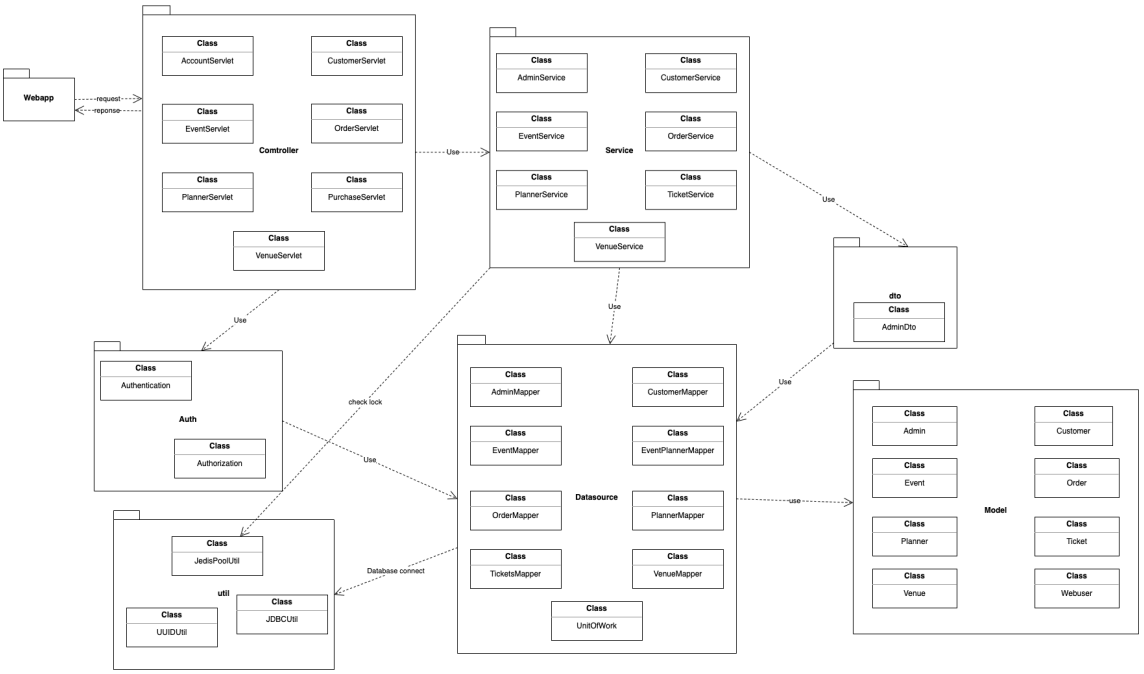


figure 1: High-level class diagram of the packages

2.2 Class Diagram

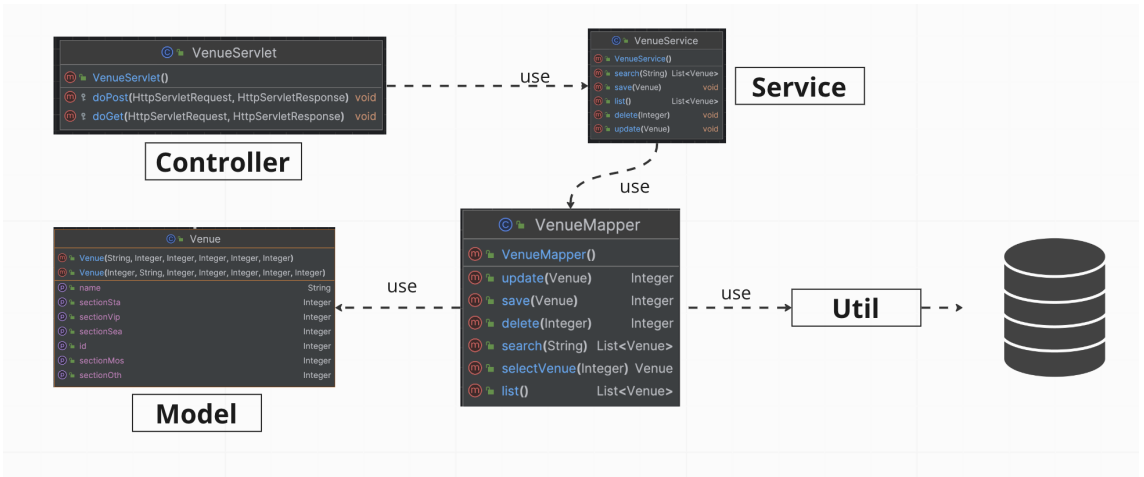


figure 2 : Main association between these class diagrams

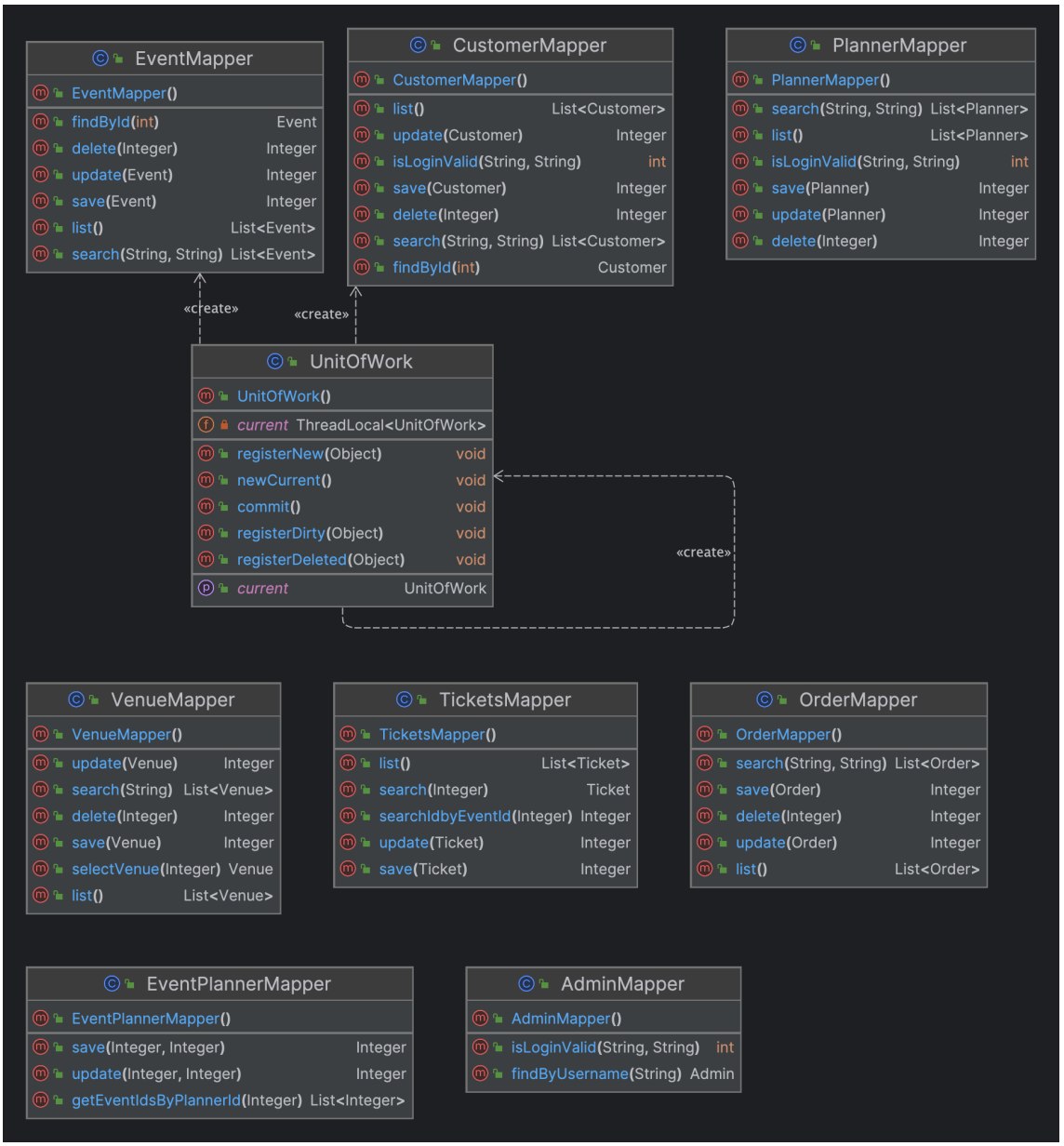


*Figure 3 : Class diagram for **datasource** package*

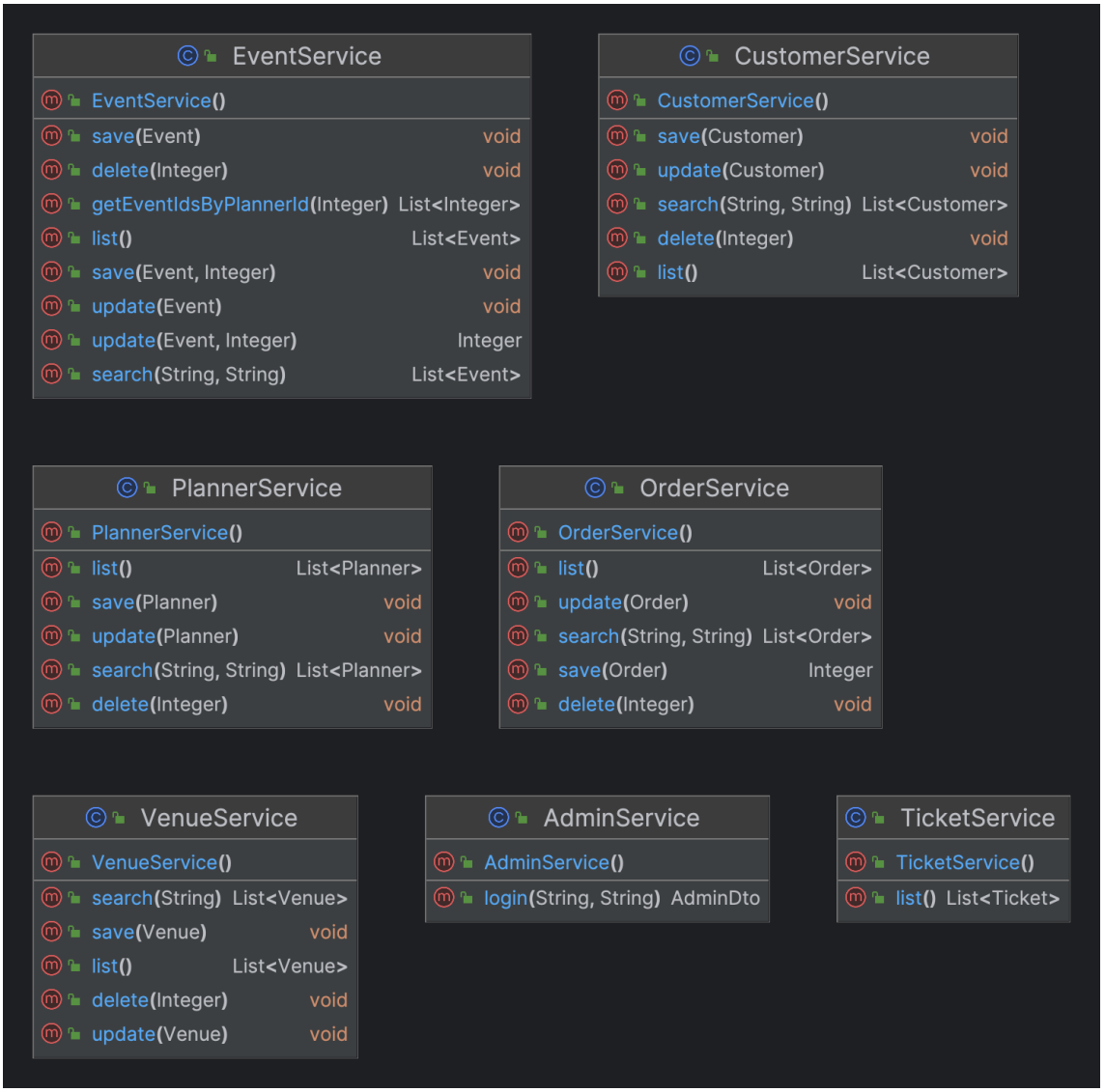


*Figure 4 : Class diagram for **service** package*

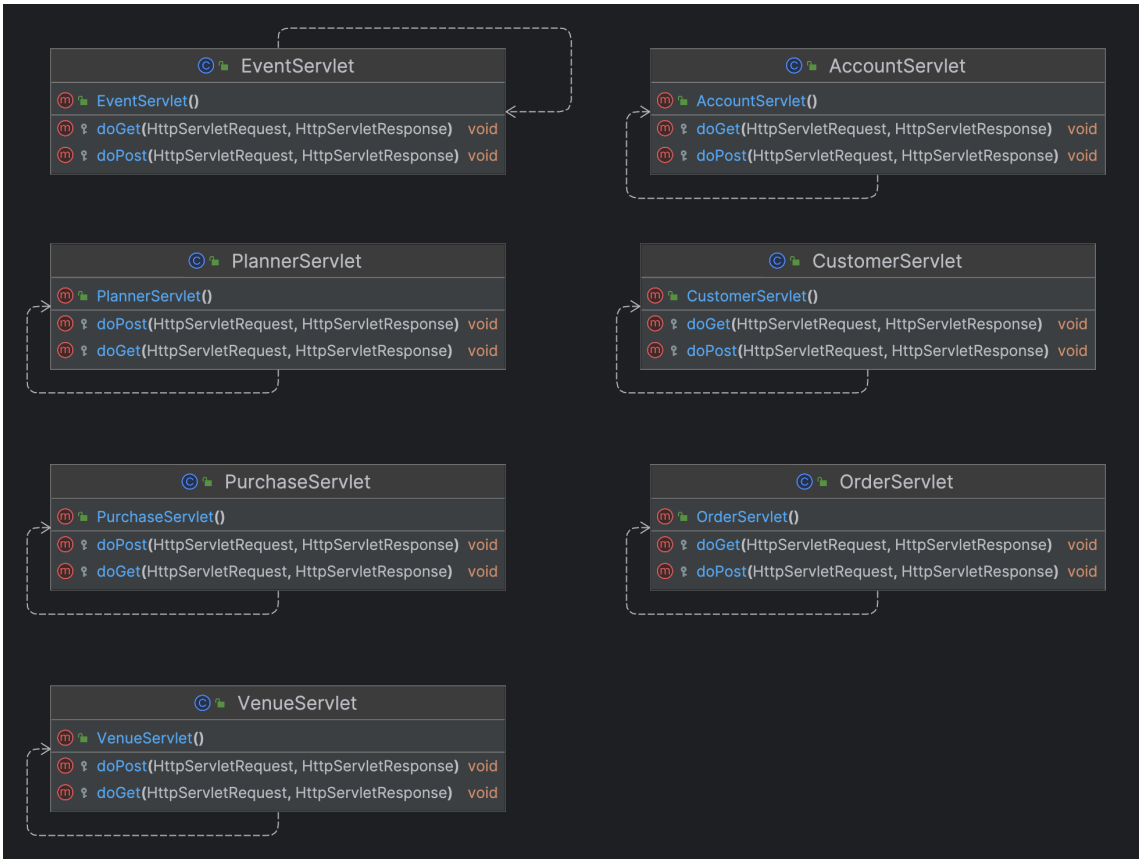


*Figure 5 : Class diagram for **controller** package*

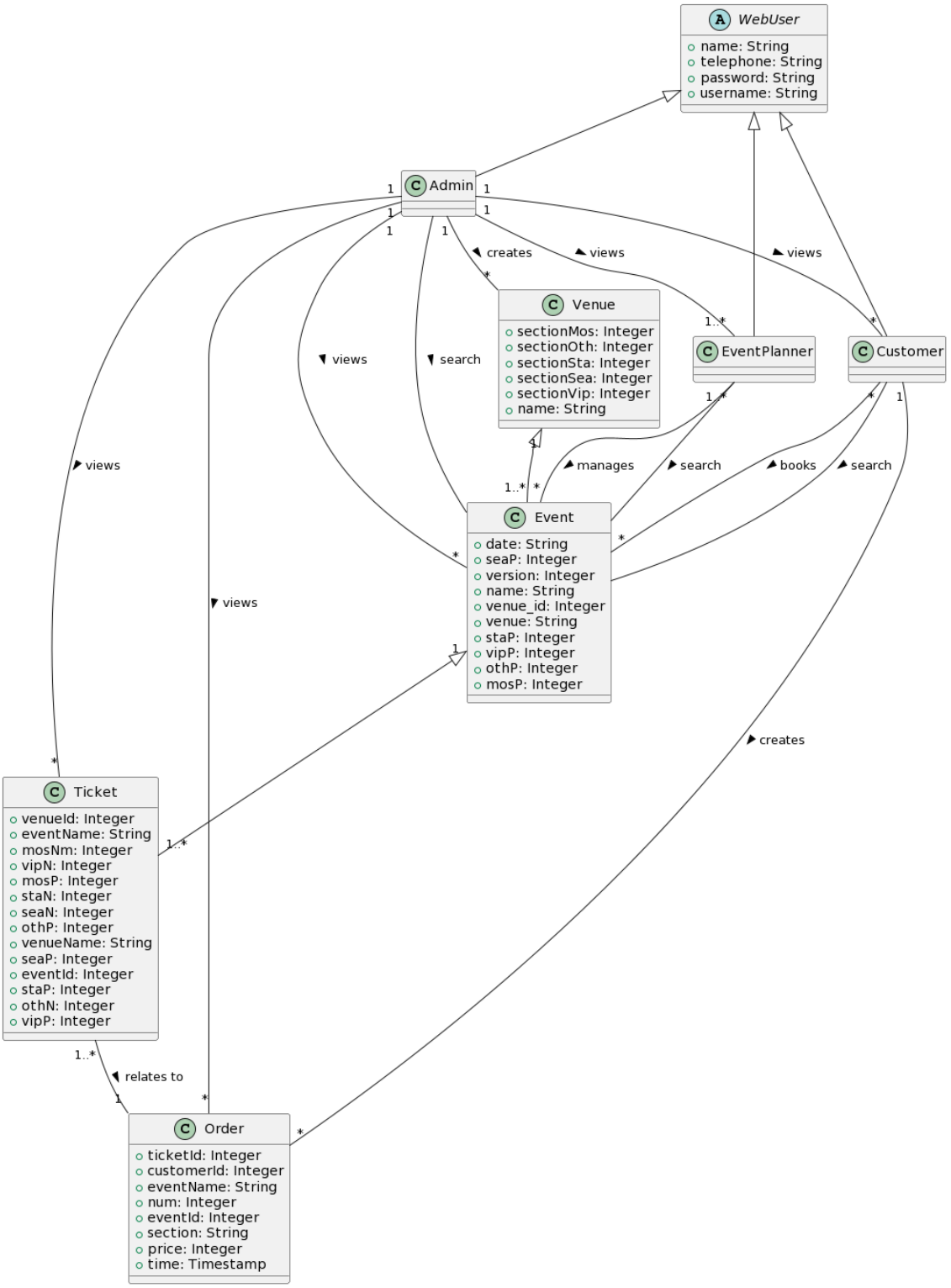


*Figure 6 : Class diagram for **Domain Model** package*

3. Covered Requirements

This section lists the system requirements covered in the test cases.

3.1 Functional or Product Requirements

Requirement Identifier	Requirement Name
UC018	Modify Event
UC024	Book Tickets

4. Concurrency Issues

4.1 Use case 18 Modify Event

4.1.1 Issue 18.1 : Concurrency Conflict on Ticket Pricing

Description: When several Event Planners simultaneously attempt to adjust the ticket prices of the same event, there's a risk of causing pricing overwrites or introducing pricing inconsistencies.

Proposed Solution Pattern: Implement an Optimistic Locking strategy paired with a Real-time Notification system specifically for ticket pricing changes that come into conflict.

Rationale: Utilizing Optimistic Locking, the system will allow concurrent ticket pricing adjustments but will scrutinize for conflicts prior to confirming those changes. If one Event Planner's price modification conflicts with another's, the Real-time Notification system would promptly alert the involved Event Planners about the conflicting price adjustments. They can then collaboratively review, discuss, and decide on the most appropriate ticket price. This approach ensures that ticket pricing updates are meticulously coordinated, preventing unintended overwrites and maintaining the accuracy of event ticket pricing.

4.2 Use case 23 Booking tickets

Based on the project requirement analysis, the ticket booking feature can be accessed by a single customer, and also supports multiple customers accessing it simultaneously. Therefore, when multiple customers are booking tickets at the same time, concurrency issues may arise.

4.2.1 Issue 23.1 : Duplicate Ticket Orders

Description: When a customer is making a purchase, operational issues could lead to the same ticket order being placed multiple times, which is essentially the problem of duplicating orders.

Proposed Solution Pattern: pessimistic lock on the order object

Rationale: During the purchasing process, once a customer initiates a ticket booking request, the control handles the front-end request, and then calls the save function provided by the service to submit the newly created form to the database. However, if the user makes multiple clicks due to a delay, multiple forms would be created. If the form hasn't been fully submitted, then the duplicate forms will obtain the same data and submit it to the database, thereby causing errors. To address this issue, a pessimistic lock can be added when processing the order form to ensure the correctness of the ticket booking process.

Issues test:

Condition: Multiple users are ready to buy Taylor Swift standing tickets with 20 remaining in stock.

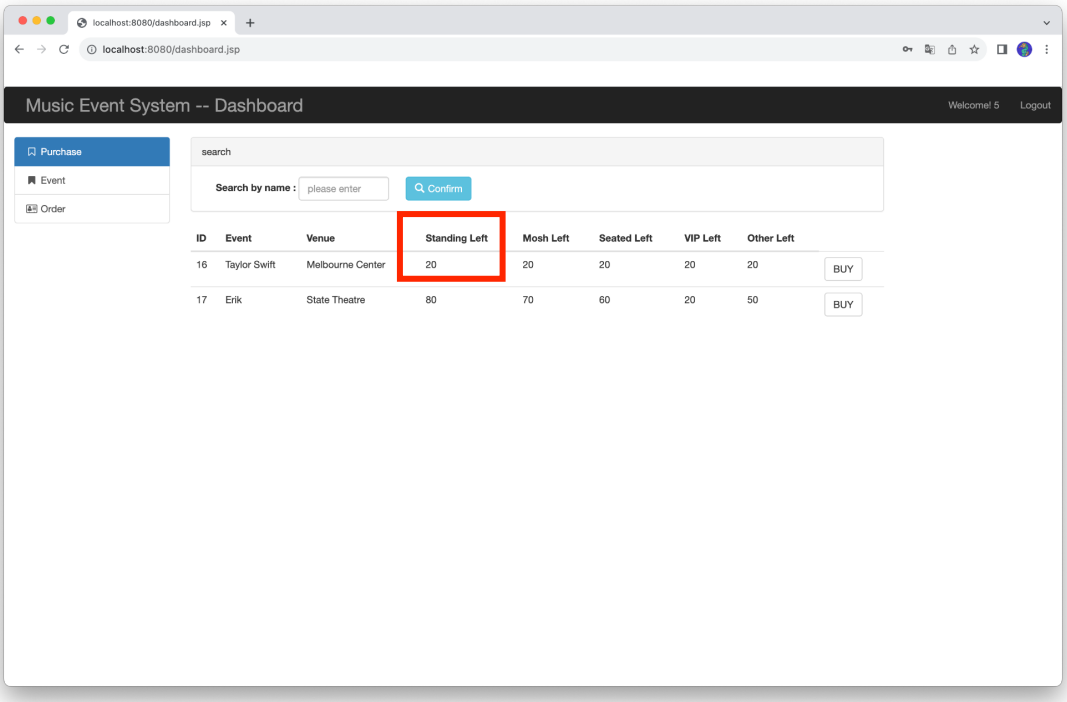


Figure 7 : Inventory situation

Test: Ten purchases occur in one second.

Figure 8 : Concurrent request configuration

Outcome: Ten orders were created successfully.

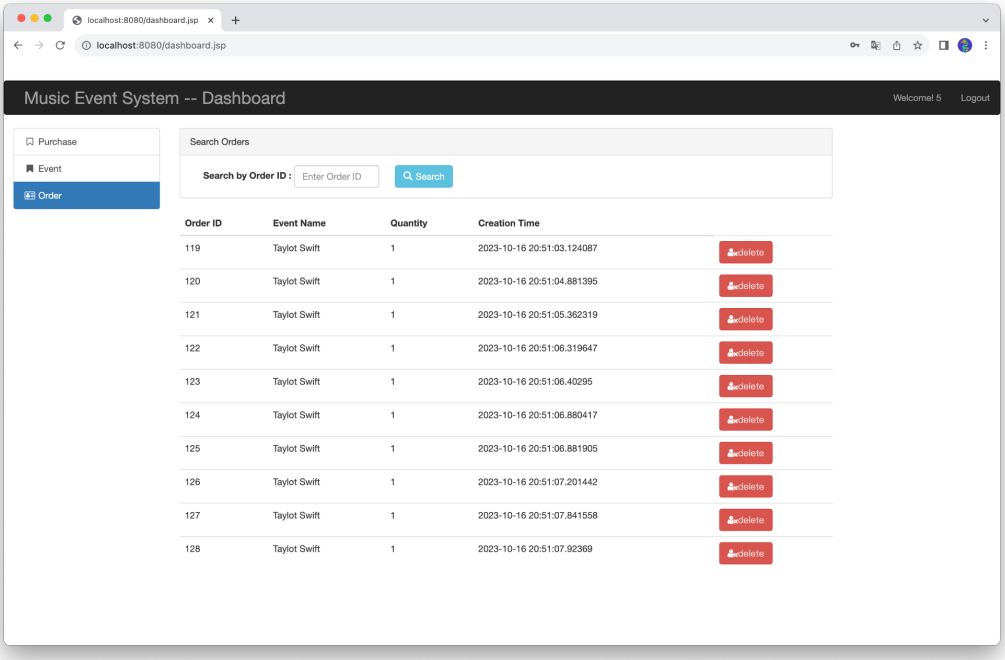


Figure 9 : Snap up orders

But the inventory is down by two tickets, so the two tickets were purchased repeatedly.

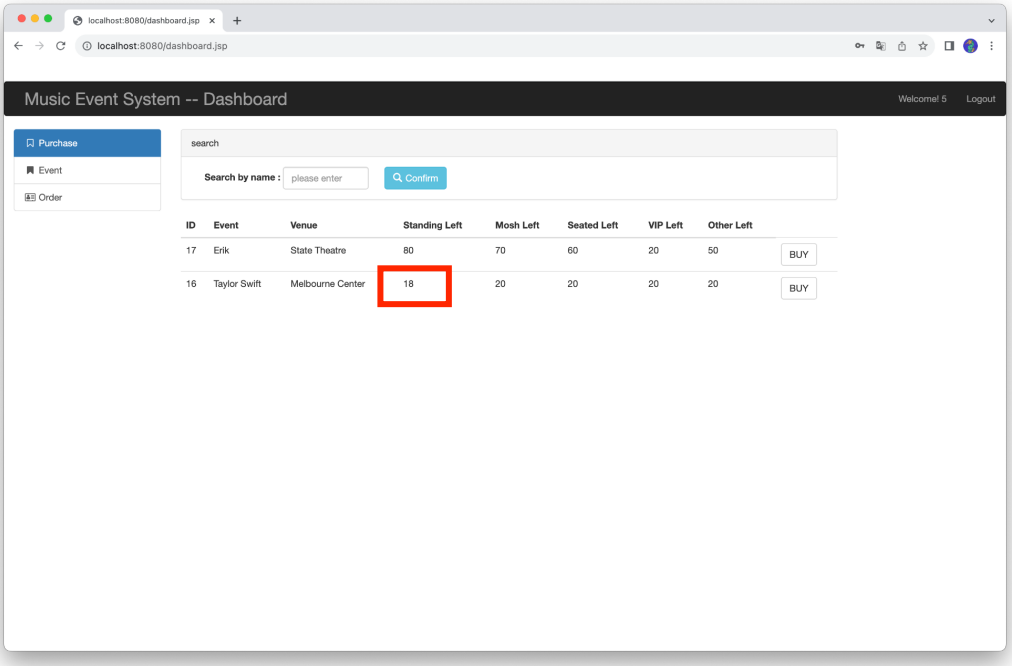


Figure 10 : Stock situation after buying

4.2.2 Issue 23.2 : Overbooking Due to Concurrent Purchases

Description: When multiple customers are making purchases simultaneously, it's possible to encounter situations where the number of orders exceeds the current remaining ticket quantity, thus going beyond the scope of ticket purchases.

Proposed Solution Pattern: pessimistic lock on the order object

Rationale: During the ticket purchasing process, multiple consumers are allowed to carry out ticket purchasing actions simultaneously. The determination of whether a ticket purchase can be successfully completed, i.e., whether there are remaining tickets, is made prior to the purchase. Therefore, when multiple users are booking tickets at the same time, if one user's ticket purchase hasn't been committed to the database while other users have also initiated ticket purchasing actions, the remaining ticket count wouldn't have been updated at this point, leading to the scenario of ticket sales exceeding the remaining tickets. To resolve this issue, a pessimistic lock can be added to the order object to ensure correctness.

Issues test:

Condition: Multiple users are ready to buy Taylor Swift standing tickets with 2 remaining in stock.

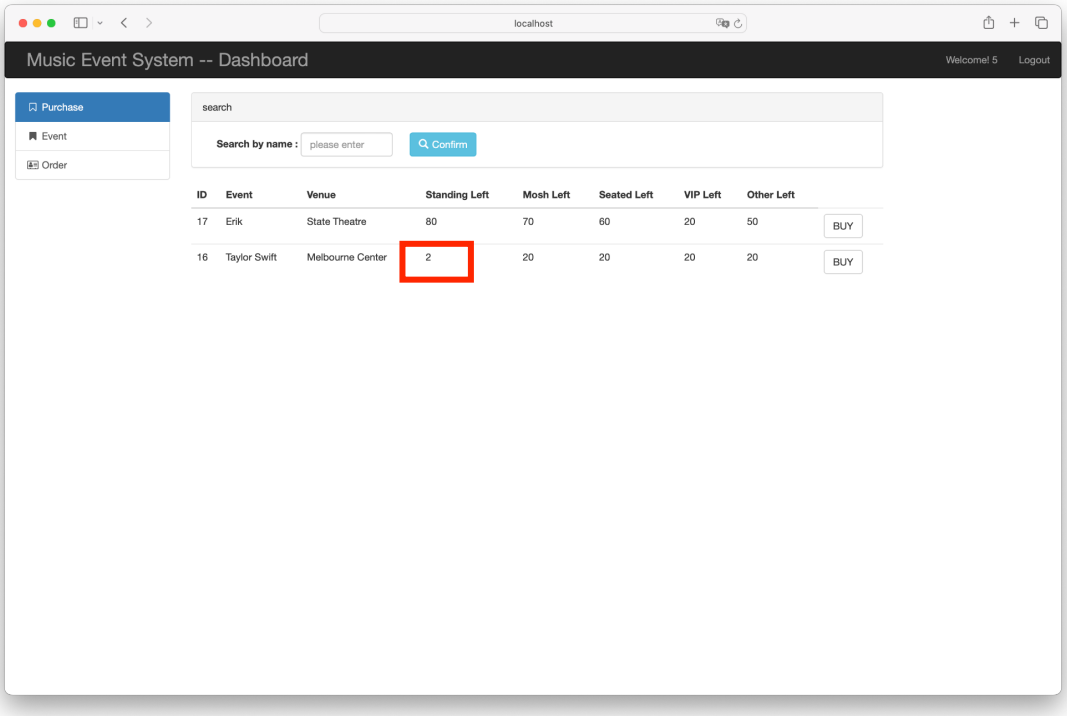


Figure 11 : Inventory situation

Test: Thirty purchases occur in three seconds.

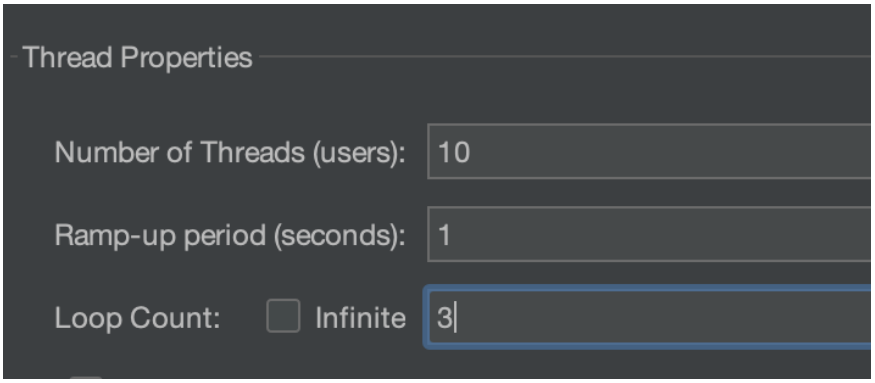


Figure 12 : Concurrent request configuration

Outcome: Inventory is negative.

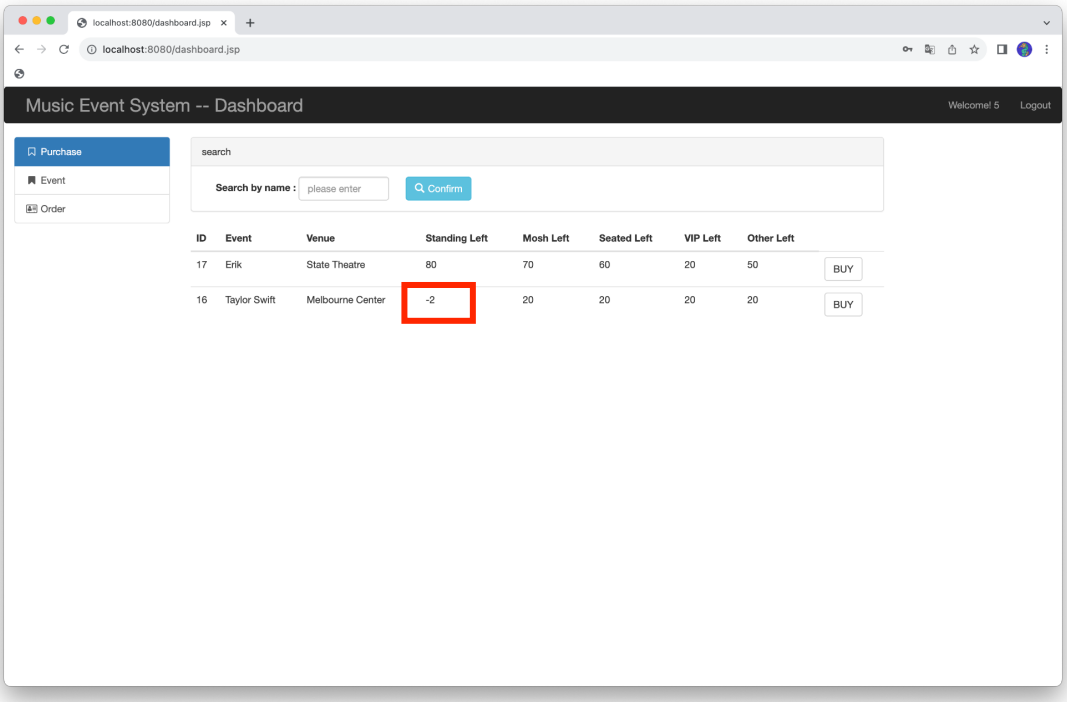


Figure 13 : Stock situation after buying

5. Implemented concurrency patterns

5.1 Pessimistic Lock

In music event systems, we classify the situations in which concurrency can occur into two categories. One is high concurrency and requires strong consistency, such as ticket purchasing. Since the ticketing operation is not atomic, when users snap up tickets for popular music events, it may happen that the same ticket is purchased repeatedly, or the number of purchases may exceed the number in stock. This type of situation involves monetary transactions, so strong consistency is required. So for the ticket-buying operation, we use pessimistic locking.

As the name suggests, the strategy of pessimistic locks is extremely pessimistic. Once a thread is ready to make a change to some data, it is assumed that concurrency issues must arise. Therefore, the thread applies a pessimistic lock to the data at the beginning of the operation and releases the lock when the operation is complete. When the lock acquisition fails, it waits or exits. Pessimistic locking achieves strong consistency by making operations serial, while also degrading performance.

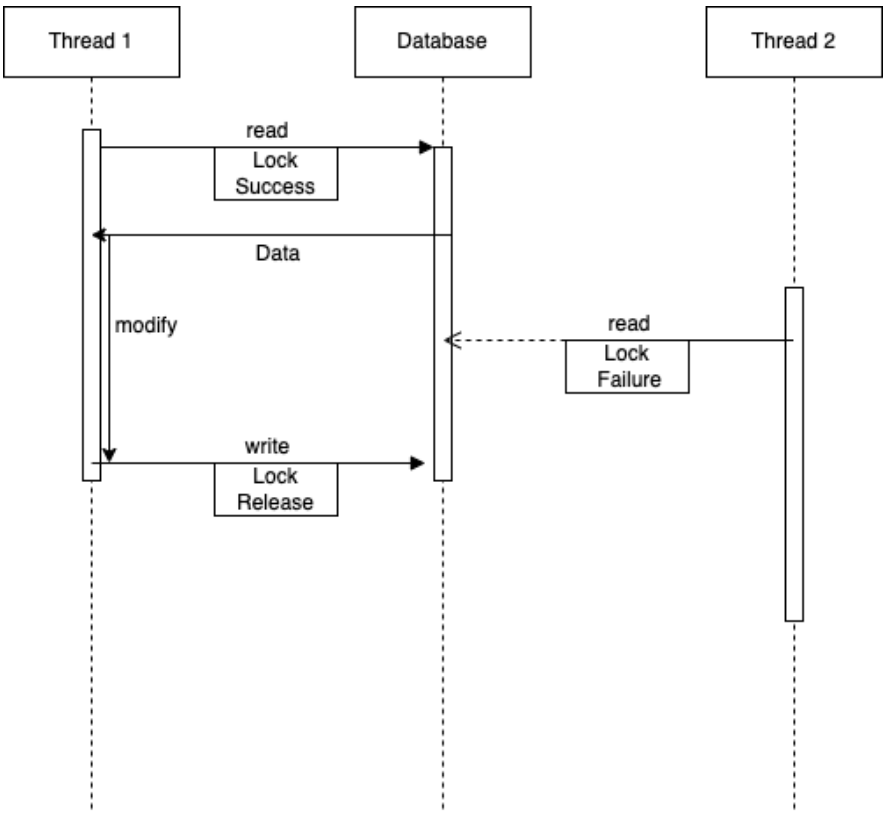


Figure 14 : Pessimistic lock sequence diagram

Because Redis performs well and is easy to implement distributed locking. So we adopt jedis, the java client of redis, to implement pessimistic locking. During the implementation I ran into the following issues, which have been resolved. The solution is in the code. Here's the key code:

Acquire lock

```
JedisPool jedisPool = JedisPoolUtil.getInstance();
Jedis jedis = jedisPool.getResource();
String value = UUID.randomUUID().toString();
int lock = ((int) jedis.setnx("ticketlock", value));
jedis.expire("ticketlock", 30);
```

Release lock

```
String lua = "if redis.call(\"get\",KEYS[1])==ARGV[1] then\n" +
        "return redis.call(\"del\",KEYS[1])\n" +
        "else\n" +
        "return 0\n" +
        "end";
```

```
String scriptLoad = jedis.scriptLoad(lua);
jedis.evalsha(scriptLoad, Collections.singletonList("ticketlock"),
Collections.singletonList(value));
```

5.1.1 Lock and Release

Redis provides a command to implement distributed locking, SETNX, which sets the key to value only if it does not already exist and does nothing if the key exists. Based on this feature, we can implement a distributed lock using Redis.

5.1.2 Lock Timeout Problem

If the service that acquired the lock goes down before releasing the lock, then the lock-stock in Redis will exist forever, so the lock cannot be released, and other services will not be able to acquire the lock, resulting in a deadlock. In order to solve this problem, we need to set an automatic timeout of the lock, which is the timeout of the Key. Even if the service fails without calling del to release the lock, the lock itself has a timeout, which can be automatically removed and acquired by another service, and the expiration time of the Key in Redis can be implemented using command “expire (lock, 30)”.

5.1.3 False Lock Removal Problem

When DEL releases the lock, it may accidentally delete the lock added by others. For example, A acquires the lock lock_stock with an expiration time of 10s. If the lock expires automatically and another service obtains the lock lock_stock during the period during which service A executes the service logic, then the del(lock_stock) of service A will remove the lock of others.

The solution is to first determine if the lock you want to remove is a lock you already own. For example, the value of the lock can be used as a UUID. When releasing the lock, it first checks whether the value of the lock is the same as the UUID created in the current service, and if so, it can execute del to remove the lock.

5.1.4 Synchronized Problem

In 4.1.3, the lock removal process is performed in three steps: query, judge, and delete, which is not atomic. If service A decides to remove the lock and the lock expires automatically, another service B acquires the lock, and then service A executes DEL, it may remove the lock from service B. Therefore, lock lookup, lock judgment, and lock removal must be done atomically. The solution can use Redis and Lua scripts to solve the consistency problem. In Redis, Lua scripts can guarantee atomicity for multiple commands. Besides, using the scriptLoad(lua) function to preload scripts to the redis server can improve performance.

5.2 Optimistic Lock

Concurrency also occurs when there are multiple planners working on the same event at the same time in the event management interface. However, the amount of concurrency is not high, and there are more reads than writes. That's why optimistic locking is appropriate.

Optimistic lock is very optimistic when operating data, and it is believed that others will not modify the data at the same time, so optimistic lock will not lock the data before updating the data. Only when the data is updated, judge whether the data is modified. If the data is modified, it will give up the current modification operation.

The optimistic lock was implemented to combat any conflicts in event details that can arise when the same event is being modified by a different planner. The system allows for multiple planners to be assigned as co-planner for a single event, and there can be situations where both co-planners are making changes to the event at the same time. In order to ensure that the co-planner is modifying the most recent event details, the optimistic lock was chosen so that when there are inconsistencies between event versions on commit, the co-planner is forced to fetch the latest version and start again.

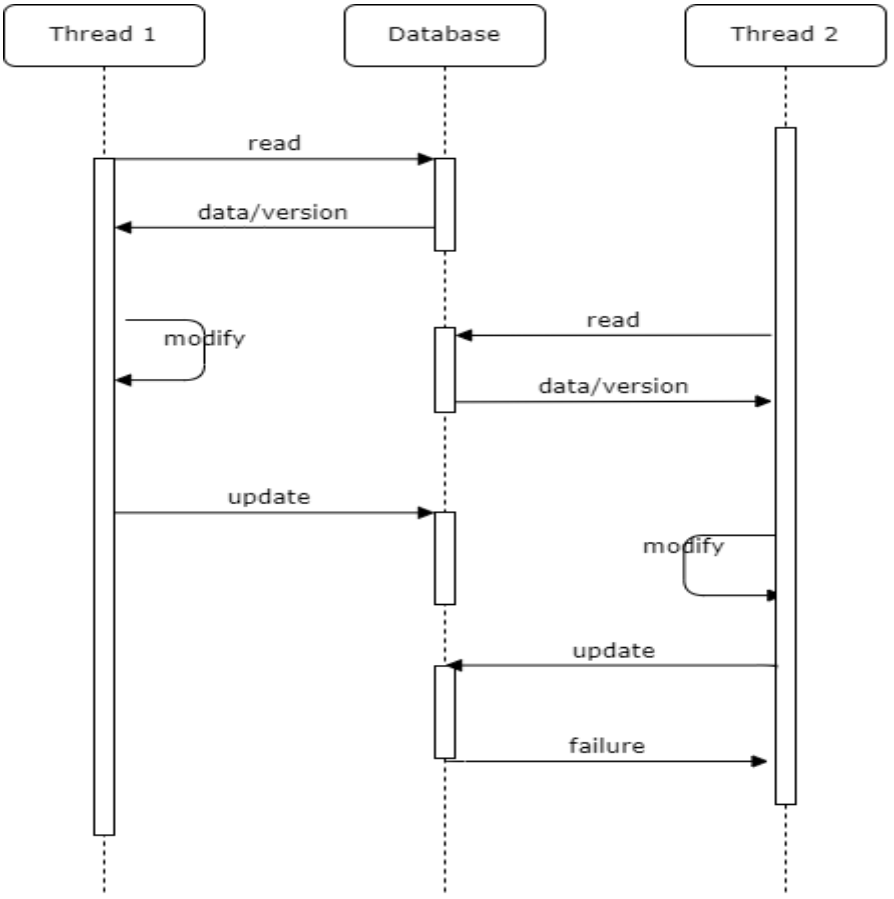


Figure 14 : Optimistic lock sequence diagram

During the read operation, along with the data, a version number (or timestamp) associated with the data is also fetched. When an attempt is made to update the data, the system checks the current version number (or timestamp) of the data against the version number that was fetched during the read operation. If the version numbers match, it means no other transaction has modified the data, and the update can proceed. If they don't match, it indicates that the data has been modified by another transaction since it was last read, and the update is rejected.

6. Functional Test Cases

This section describes the test cases that cover the product requirements of the system.

6.1 UC018: Modify Event

6.1.1 TC18.1: Event Planners Modify Event Details

This test is designed to validate that Event Planners can smoothly adjust the ticket prices for an event without encountering any system glitches. The privilege to modify ticket prices should be limited exclusively to Event Planners associated with the specific event, ensuring the accuracy and reliability of the pricing information. Additionally, when adjusting ticket prices, the system should ensure that the modification does not create conflicts or discrepancies with ticket prices or promotions of other events scheduled at the same venue and time, thereby preventing potential pricing differences or confusions.

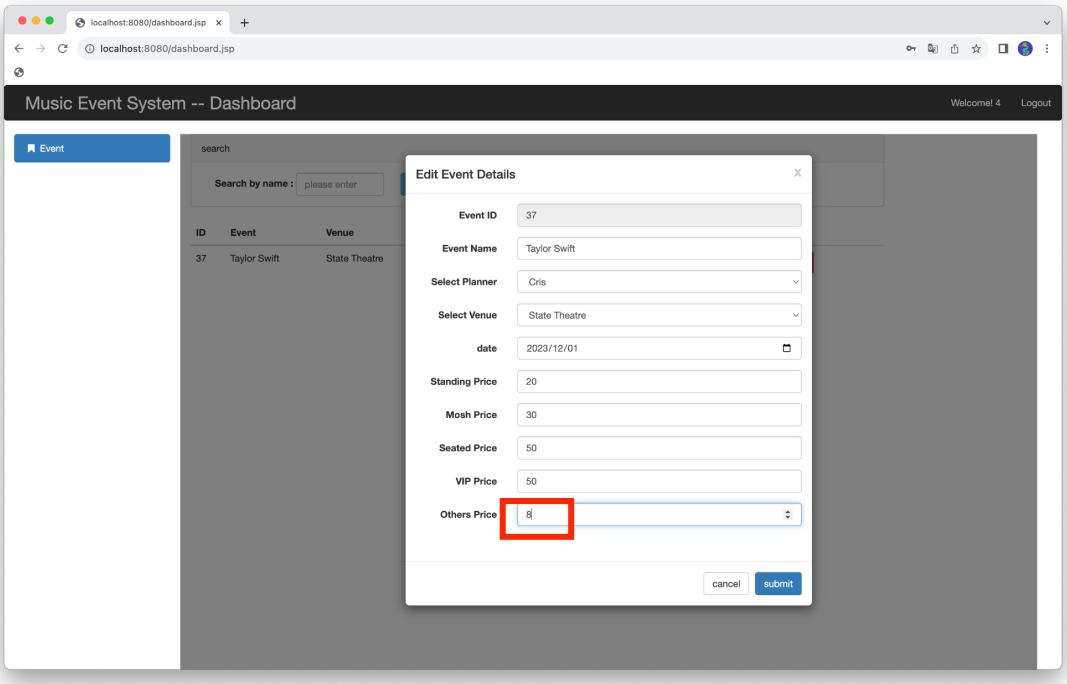
Test Type: Functional	**Execution Type:** Manual testing
Objective: ➢ Ensure event details are consistently updated without system errors. ➢ Confirm only the associated Event Planners can modify event details. ➢ Ensure no modification is allowed if it conflicts with another committed modification.	
Setup: 1. Event Planner “joker” login into account 2. Event Planner “planner1” login into account 3. “joker” adjust the “Other Price” to 8 4. “planner1” adjust the “Other Price” to 9 simultaneously	
Pre-Conditions: ➢ Event Planner is logged into the system.	

- Event to be modified exists in the system.
- The Event details can be modified.

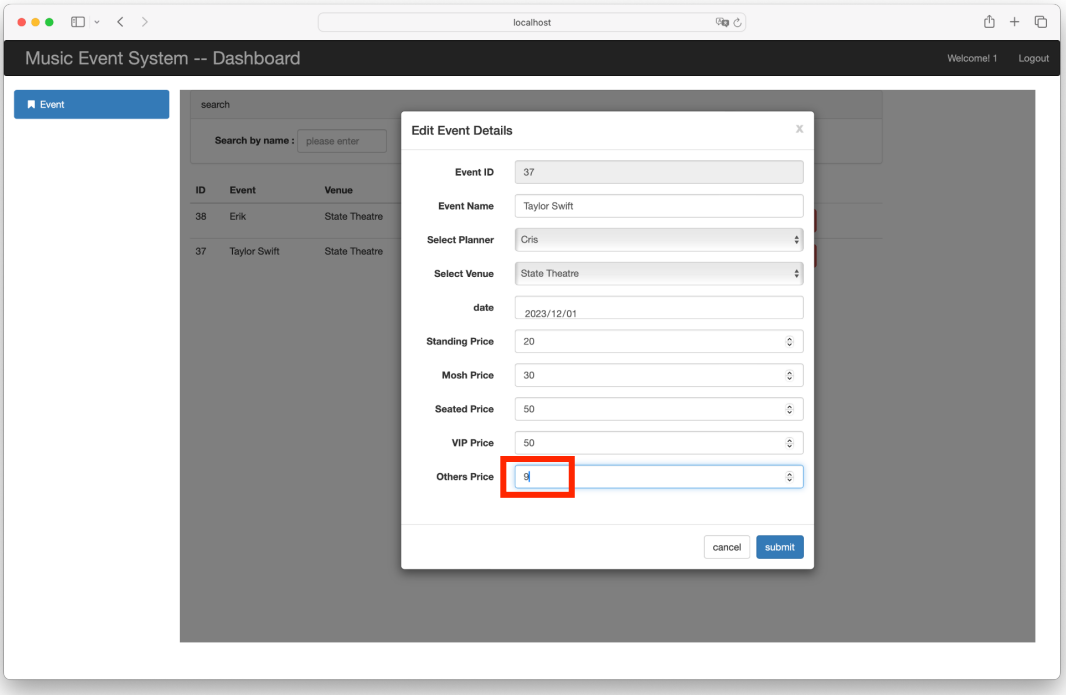
Expected Outcomes:

- Event details are successfully updated by the Event Planner.
- System prevents one of the Event Planners from making changes to the event.
- System prevents modifications that would cause scheduling conflicts.

Notes:



Result:


localhost
Music Event System -- Dashboard
Welcome! 1
Logout
Event
search
Search by name :
please enter
ID
Event
Venue
38
Erik
State Theatre
37
Taylor Swift
State Theatre
Edit Event Details
Event ID
37
Event Name
Taylor Swift
Select Planner
Cris
Select Venue
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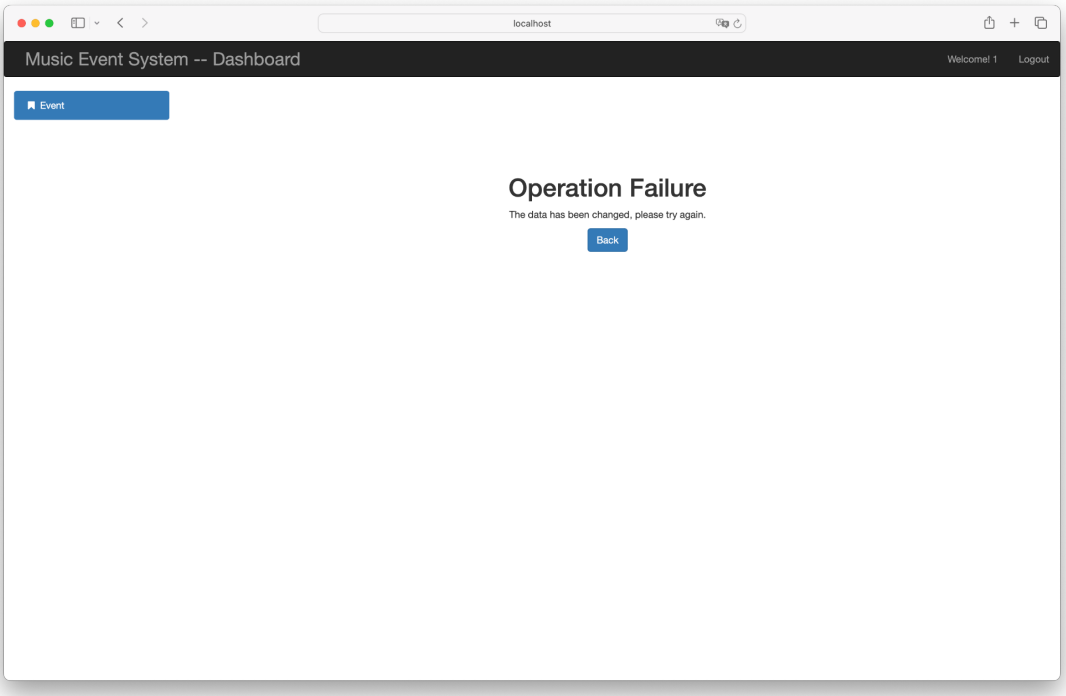
20
Mosh Price
30
Seated Price
50
VIP Price
50
Others Price
9
cancel
submit


localhost
Music Event System -- Dashboard
Welcome! 1
Logout
Event
Operation Failure
The data has been changed, please try again.
Back

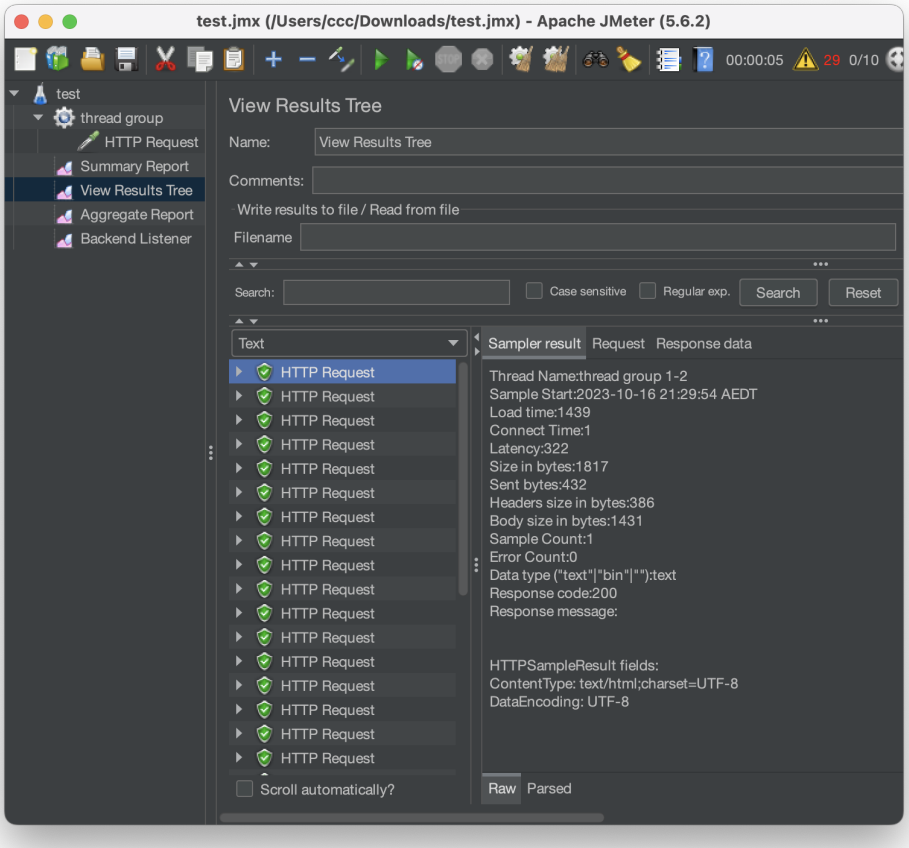
Time constraint: Minimum: 20 min Maximum: 25 min

6.2 UC024: Book Tickets

6.2.1 TC24.1: Multiple Customers Booking Simultaneously

In scenarios where multiple customers attempt to book tickets simultaneously for the same event, section, and seat, the system should be capable of handling such concurrency. The objective of this test is to verify that the system efficiently manages these concurrent booking attempts, ensuring that only one customer successfully secures the seat while promptly marking it as unavailable for others. The test also aims to confirm that subsequent customers are immediately notified of the seat's unavailability, preventing potential double-bookings and ensuring a smooth user experience.

Test Type: Functional	**Execution Type:** Automated testing
Objective: ➢ Ensure system consistency and liveness during simultaneous bookings. ➢ Confirm that once a seat is booked by a customer, it is immediately marked as unavailable to others.	
Setup: 5. Open TC24.1.jmx 6. Run test plan	
Pre-Conditions: ➢ There are 20 tickets left. ➢ Two customer accounts are active in the system. ➢ Both customers have selected the same event, the same section, and the same seat for booking. ➢ The selected seat is currently available.	

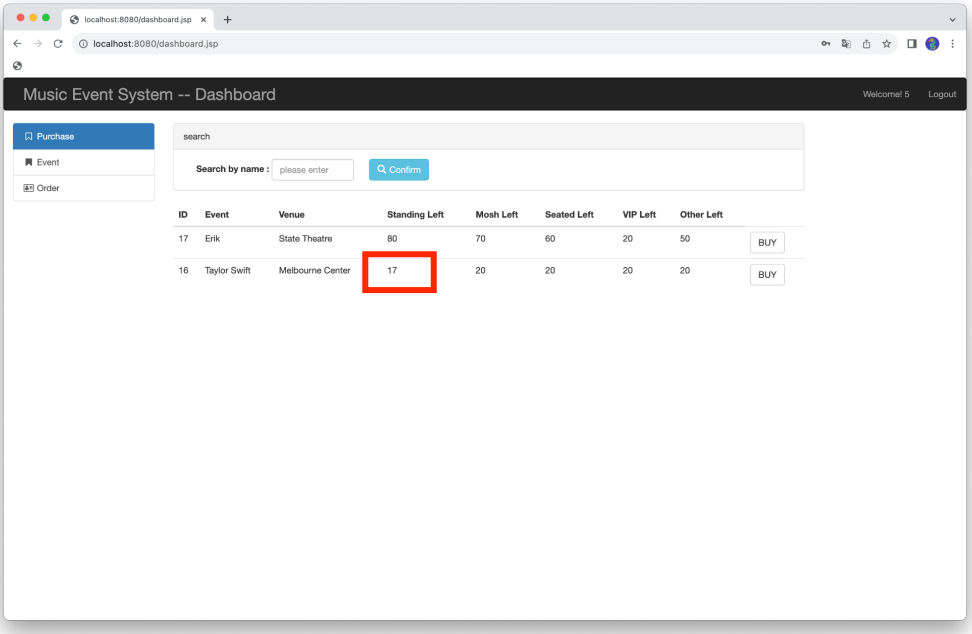


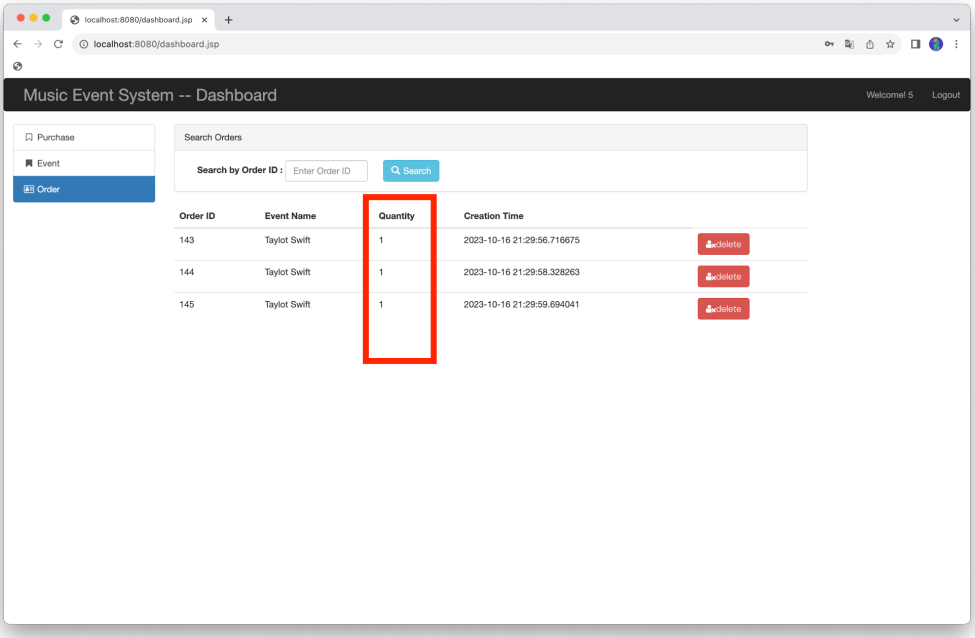
Notes:

Expected Outcomes:

- Inventory reduction is equal to the number of orders.
- Some requests failed.

Result:





Time constraint:

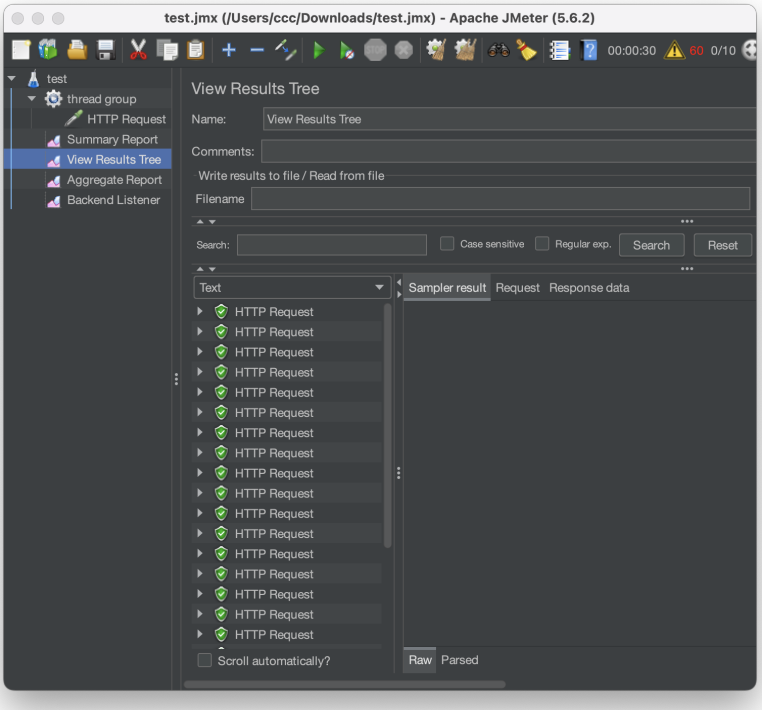
Minimum: 20 min
Maximum: 25 min

6.2.2 TC24.2: Last-Ticket Scenario

In high-demand ticket scenarios, especially when only a few tickets remain, it's critical for the booking system to handle simultaneous booking attempts with precision and fairness. This test is designed to simulate and evaluate the system's performance in such a "Last-Ticket Scenario". The objective is to ensure that only the initial successful transaction secures the remaining ticket(s), and all subsequent attempts are swiftly and clearly informed of the unavailability, preventing over-booking and ensuring user satisfaction.

Test Type: Functional	**Execution Type:** Automated testing
Objective: ➢ Ensure data consistency and liveness for the system during high-demand ticket scenarios. ➢ Verify that when multiple customers attempt to book the last few tickets simultaneously, only the first transaction is successful.	
Setup: 7. Open TC24.2.jmx 8. Run test plan	
Pre-Conditions: ➢ Only one ticket is left for a particular event. ➢ Multiple users are active and ready to book these last tickets.	
Expected Outcomes: ➢ Only the first user to finalize the transaction successfully books the last ticket(s). ➢ Other users fail when trying to create an order, indicating that the ticket is not available.	

Notes: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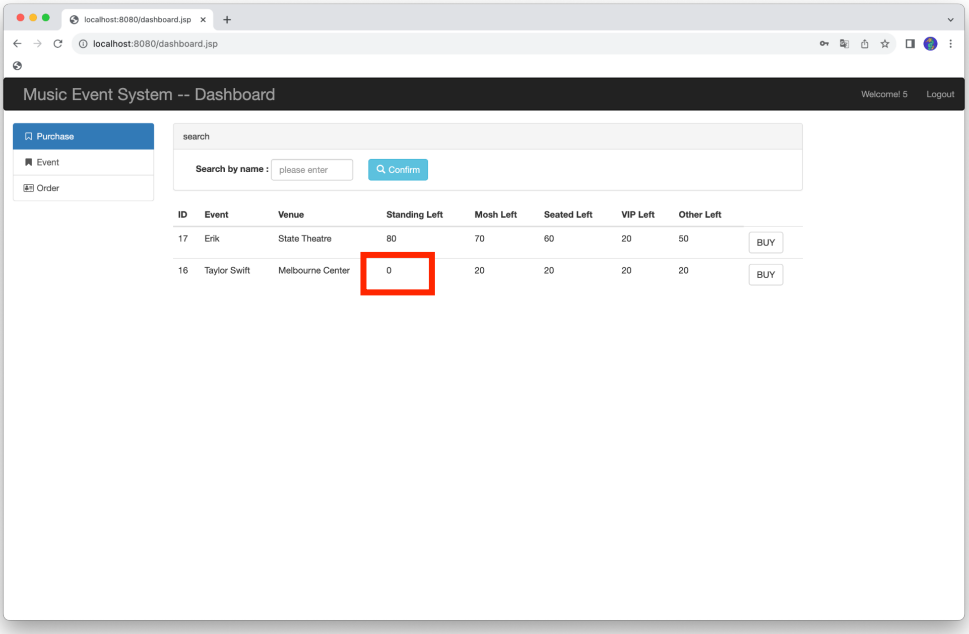
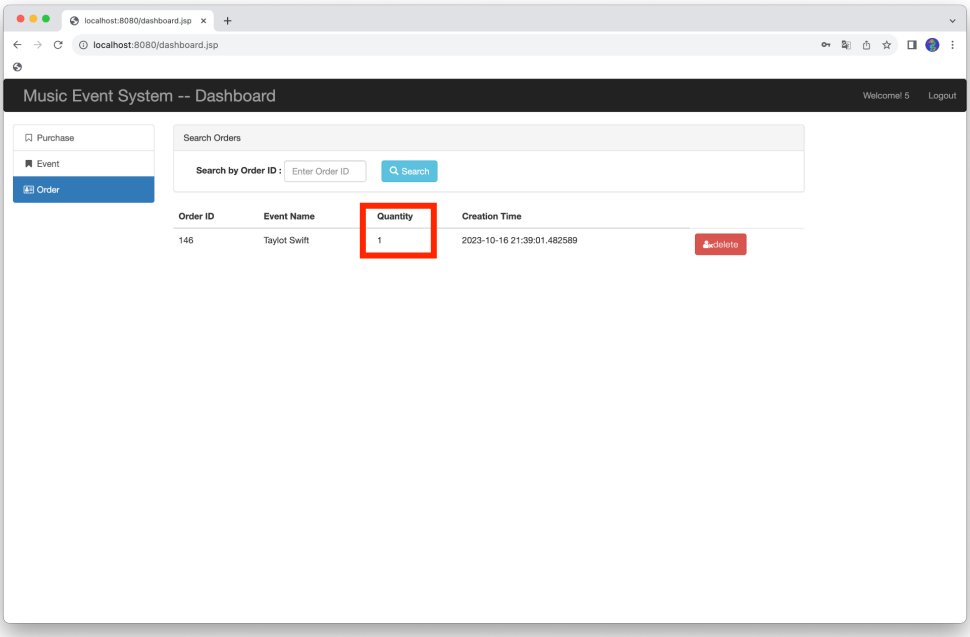
00:00:30
60
0/10
test
thread group
HTTP Request
Summary Report
View Results Tree
Aggregate Report
Backend Listener
View Results Tree
Name:
View Results Tree
Comments:
Write results to file / Read from file
Filename
Search:
Case sensitive
Regular exp.
Search
Reset
Text
Sampler result
Request
Response data
HTTP Request
Scroll automatically?
Raw
Parsed

Result:


localhost:8080/dashboard.jsp
Music Event System -- Dashboard
Welcome! 5
Logout
Purchase
Event
Order
search
Search by name :
please enter
Confirm
ID
Event
Venue
Standing Left
Mosh Left
Seated Left
VIP Left
Other Left
17
Erik
State Theatre
80
70
60
20
50
BUY
16
Taylor Swift
Melbourne Center
0
20
20
20
20
BUY


localhost:8080/dashboard.jsp
Music Event System -- Dashboard
Welcome! 5
Logout
Purchase
Event
Order
Search Orders
Search by Order ID :
Enter Order ID
Search
Order ID
Event Name
Quantity
Creation Time
146
Taylot Swift
1
2023-10-16 21:39:01.482589
delete

Time constraint: Minimum: 20 min Maximum: 25 min

7. Entry Data

<Define the entry data that will be used by more than one test case. Generally, these data represent form fields and are used to test field validation. It is a good practice to group them by the entities that they represent. Create a table for every group you define. Complete and / or adapt the following text.>

This section describes the entry data that will be used by more than one test case, avoiding data replication. These data are referenced by the test cases.

7.1 DATA...: <Data Set Name>

Description: admin	
username	**password**
admin1	*123123*

Description: planner	
username	**password**
joker	*123*
plannerrrr	*123123*
planner1	*123321*

Description: customer	
username	**password**
superman	*123*

Jenny	*520*
ccus	*123456*