



POLITECNICO

MILANO 1863

DD

Design Document

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1 INTRODUCTION

1.1 Purpose

The purpose of the project CLup (CustomerLine-up) is to develop a digital system of lining up that saves people from having to stand outside of stores for hours, avoids crowds inside the store, and, more in general, allows to regulate the influx of people in the stores.

The idea is to create a digital version of the traditional mechanism of lining up that is easy to use by everyone. In this way, the system would help to deal with the strict rules imposed by the government due to the global pandemic.

The system should give customers the possibility to line up from their home and approach to store only when their number is close to being called. This mechanism should avoid the situation in which the customers wait for their shift in the proximity of the store that is not an acceptable scenario in a lockdown situation.

1.2 Scope

The software should represent a digital alternative to the situation in which people retrieve a physical number that gives their position in the queue when they want to enter a store.

CLup should provide three main features:

- **Lining up:** allows customers to line up from their homes and avoids crowds outside the stores. It should include a notification system that alerts people when their number is close to being called. These alerts should consider the time customers need to get to the shop from the place they currently are and should be based on precise estimation of the waiting time. Moreover, CLup must provide effective fallback options for people who do not have access to the required technology.
- **Booking:** allows customers to book a visit to the supermarket. Since the time that it takes to visit a supermarket is not uniform, the system should give to user the possibility to specify an estimation of the duration of the visit. Alternatively, it might infer this information analysing the previous visits, if any.
- **Suggestion:** suggests different time slots for visiting the store (also on different days) to deal better with the restriction in the number of people inside the store. Alternatively, the system should propose other available supermarkets to the customers and alerts them in case a new time slot becomes available (e.g. after the deleting of a booking by another customer).

The customer that wants to use the service must be registered. Thanks to this, the system would be able to track the lining up, the booking, and the duration of the previous visits and use this information to manage better the influx of people and estimates with acceptable accuracy the waiting time.

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

Time slot	Period or day that can be chosen for a booking by the customers.
Store data	Data about the store like the number of people allowed, opening and closing times, address, name, and photo.
Reservation	A word that might indicate either a booking or a lining up in a specific store.
Active reservation	Lining up or booking that is not yet expired. It means that the reservation has been taken but customers still have to wait for their shift.
Store manager	Manager, cashier, or generic employee of a store.
Available shop	A shop that has at least one free time slot.

1.3.2 Acronyms

CLup	Customer Line-up
DBMS	DataBase Management System
MVC	Model View Controller
RASD	Requirements Analysis and Specification Document
RDBMS	Relational DBMS
SSL	Secure Sockets Layer
TLS	Transport Layer Security
UI	User interface

1.3.3 Abbreviations

G.n	Goal n-th
R.n	Requirement n-th
C.n	Component n-th

1.4 Revision history

DATE	DESCRIPTION
29/12/2020	First version. Mock-ups and their descriptions.
02/01/2021	Architectural Design: Overview and Component View
03/01/2021	Requirement Traceability
04/01/2021	Algorithms: Pseudocodes and Flowcharts
05/01/2021	Sequence diagrams integration and comments
06/01/2021	Architectural Styles and Patterns. General improvements.

1.5 Reference Documents

- *Requirement Engineering and Design Project: goal, schedule, and rules*
- *I&T assignment goal, schedule, and rules*
- Slides of the course *Software Engineering 2*

1.6 Document Structure

The document is composed of the seven following chapters:

- **Chapter 1:** provides an introduction to the purposes and the whole scenario of the software as already specified in the RASD document. First, it includes the general description of the system, then there is a sufficiently detailed specification of the main features that the system should provide. Lastly, it includes the list of abbreviations, acronyms, and definitions used in the document, the revision history, and the reference documents.
- **Chapter 2:**
- **Chapter 3:** includes some extensions and more details about the *User Interface* (UI) with respect to what was specified in the RASD document. In this section, several new mock-ups and their descriptions are included.
- **Chapter 4:**

- **Chapter 5:**
- **Chapter 6:** shows the amount of time that each member has spent to produce the document.
- **Chapter 7:** specifies the reference documents and online resources used during the production of this document.

2 ARCHITECTURAL DESIGN

2.1 Overview

From a high-level point of view, a three-tier architecture appears as a good choice for the system. This is a well-known architecture organized in three logical and physical tiers:

- **Presentation tier:** it allows the interaction with the users providing the UI and the needed communication layers. It is able both to show and acquire information from the users that use the system.
- **Application tier:** it is able to modify, add, or delete the data in the data tier. Using some defined business rules, it also processes the information from the presentation tier. It controls the application's functionalities, and it is also known as logic tier or middle tier.
- **Data tier:** here the data are stored and managed including the data persistence mechanism. It is also known as database tier, data access tier, or back-end.

All communications between presentation and data tiers are possible only using the application tier.

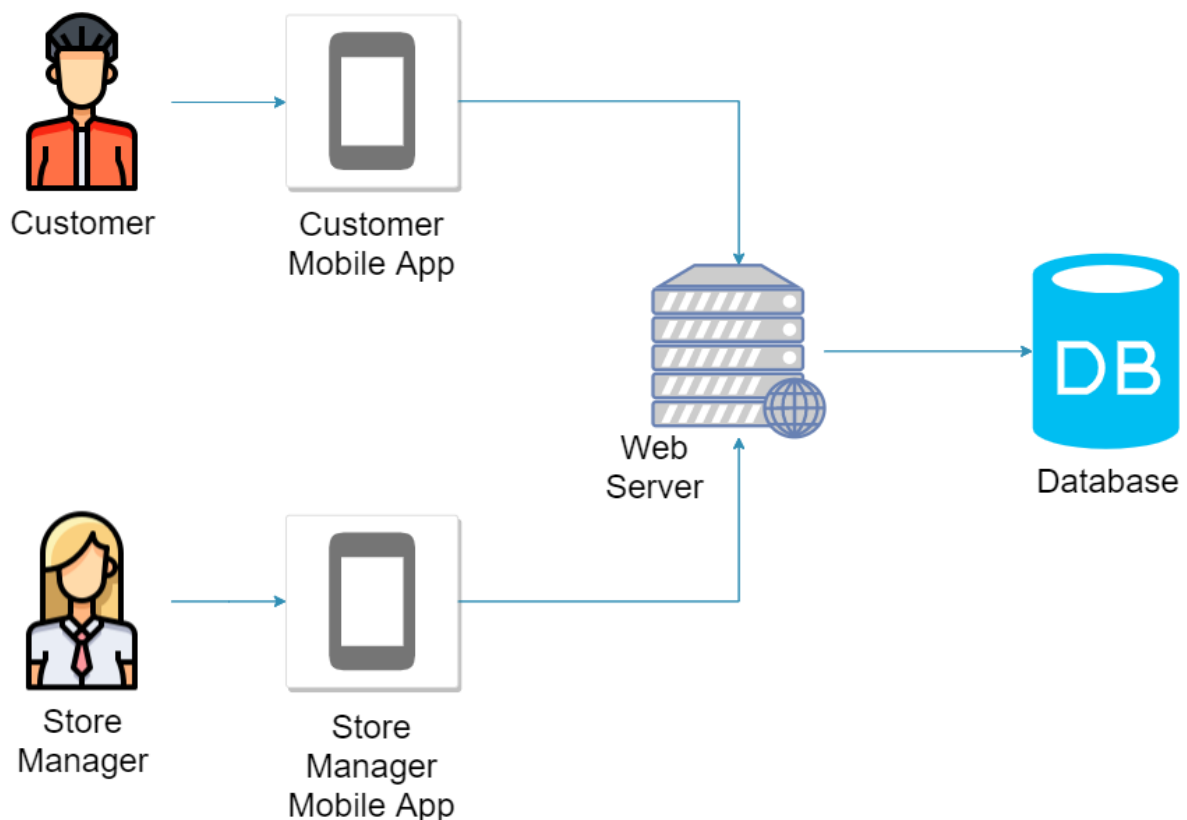


Figure 1: System Architecture

This architecture offers several advantages like the logical and physical separation of functionalities. Moreover, each tier is executed on a dedicated operating system and platform on a dedicated virtual and hardware component. Other strengths are:

- reduction of the developing time thanks to the independence of each tier with respect to the others;

- high scalability: it is possible to scale each tier independently to the others;
- high reliability: it is unlikely that an eventual failure on a specific tier has an impact on the others;
- high security: the separation of the tiers makes less likely malicious attacks like SQL injections. In particular, the presentation tier and data tier cannot communicate directly.

2.2 Component view

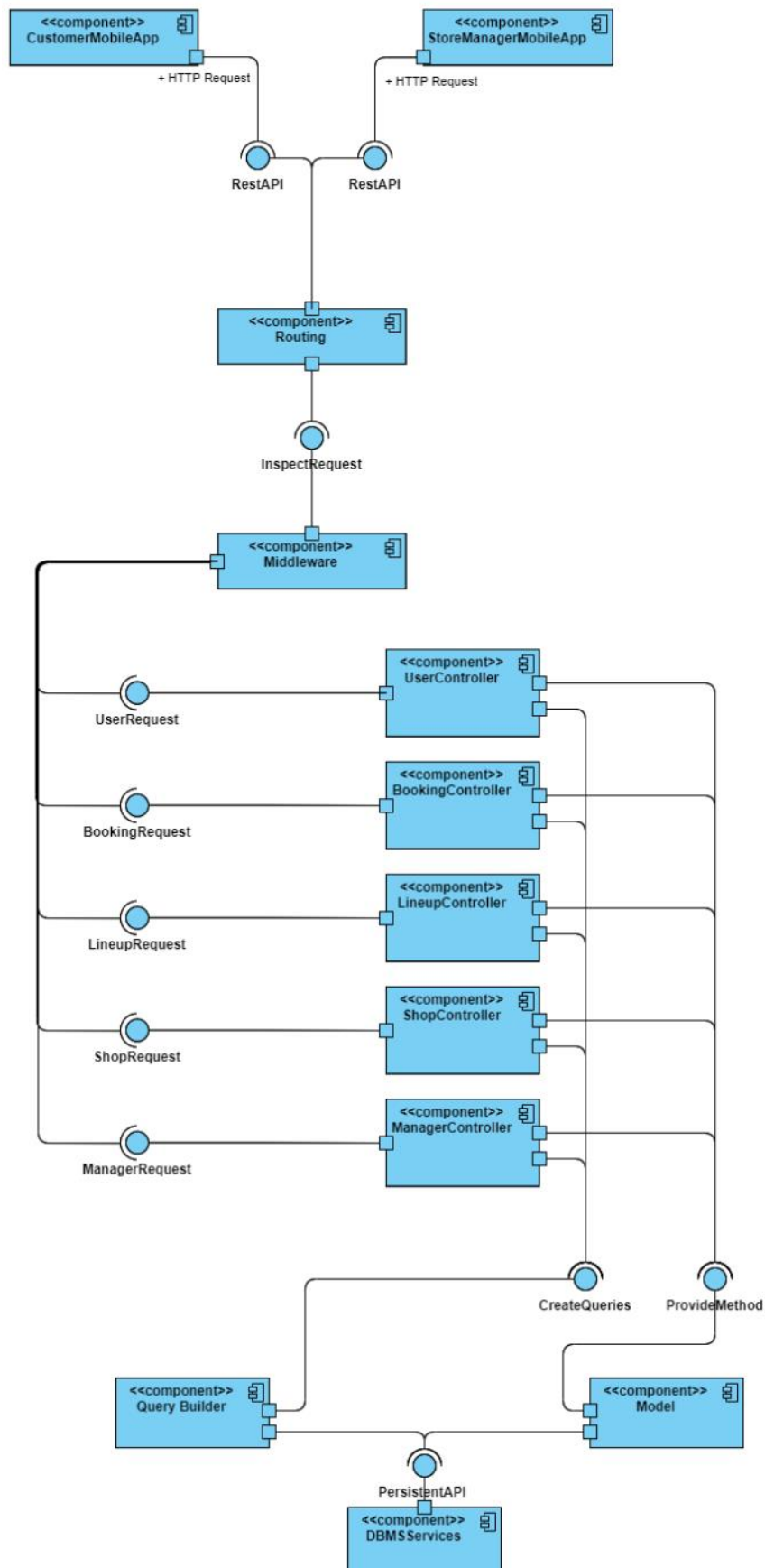


Figure 2: Component Diagram

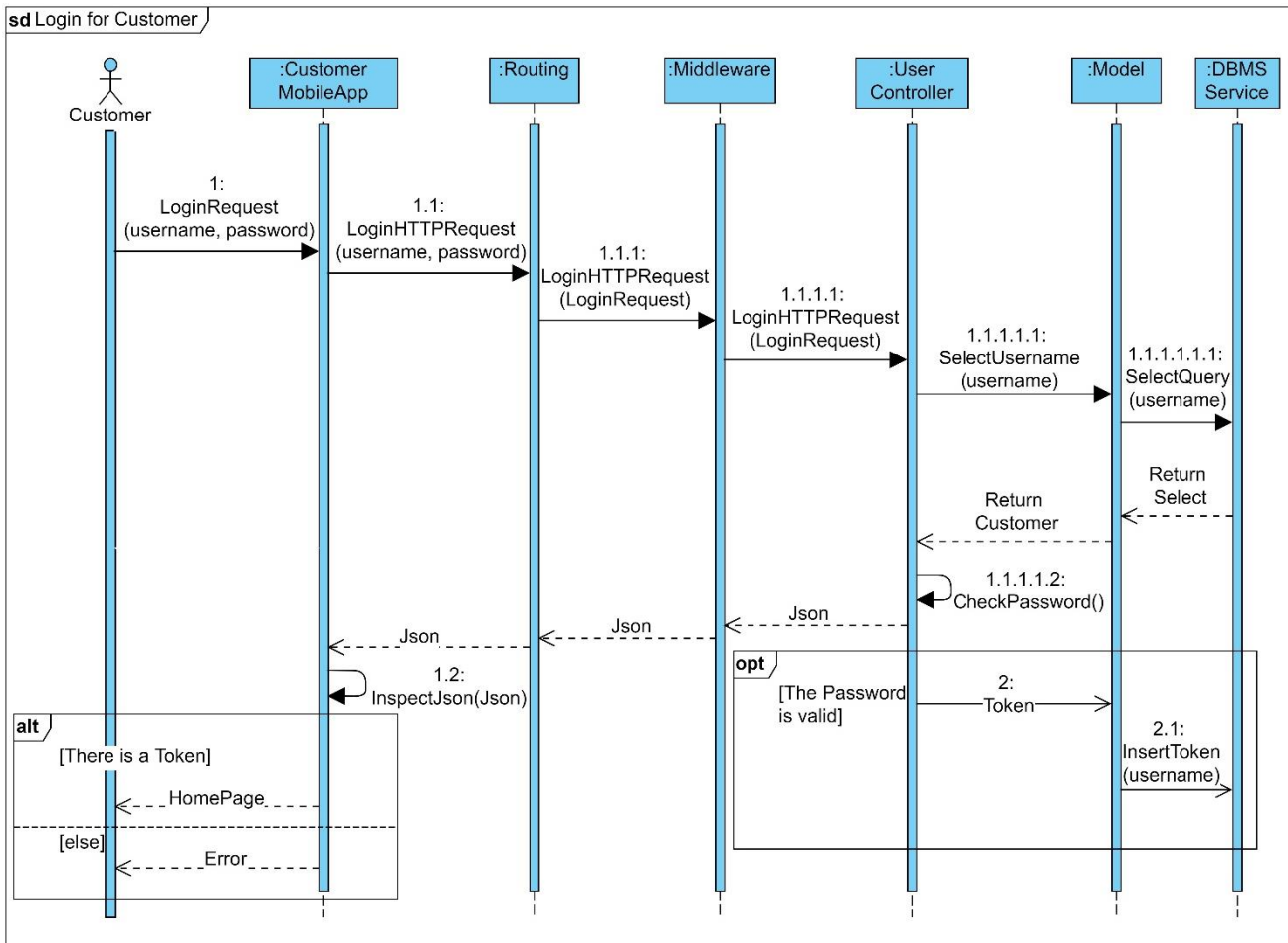
The Component Diagram represents the internal structure of the system describing the main components and links between them. It shows also how some components are wired together to create larger components. The depicted components are:

- **CustomerMobileApp**: mobile application used by the customer to access the system and its functionalities.
- **StoreManagerMobileApp**: mobile application used by the store manager to access the system and its functionalities.
- **Routing**: this component loads the route files dispatching an HTTP request to a route, a controller, or executing the necessary middlewares.
- **Middleware**: filters and examines the requests according to the specifications of the component. Particular attention was paid to the authentication middleware that checks if the users that use the application are correctly authenticated. If they are so, their request can proceed; otherwise, the request is redirected.
- **UserController**: defines customer requests. For instance, it provides the method for the customer login that checks the inserted email and password and, if they are correct, creates a unique token. This token authorizes the user to request further operations.
- **BookingController**: defines requests that create, update, and delete a booking.
- **LineupController**: defines requests that create, update, and delete a lining up.
- **ShopController**: defines shop requests. **It permits to query all available shops.**
- **ManagerController**: defines store manager requests. It allows the store manager to log in to the system.
- **Query Builder**: this component allows to create and run queries communicating with the DBMSServices. As specified in the Laravel documentation, it includes a protection mechanism from SQL injection attacks that guarantees a high level of security.
- **Model**: provides methods to access and manage data. It is used by the controller.
- **DBMSServices**: manages the creation, manipulation, and querying of the database.

2.3 Deployment view

2.4 Runtime view

1. Login for Customer



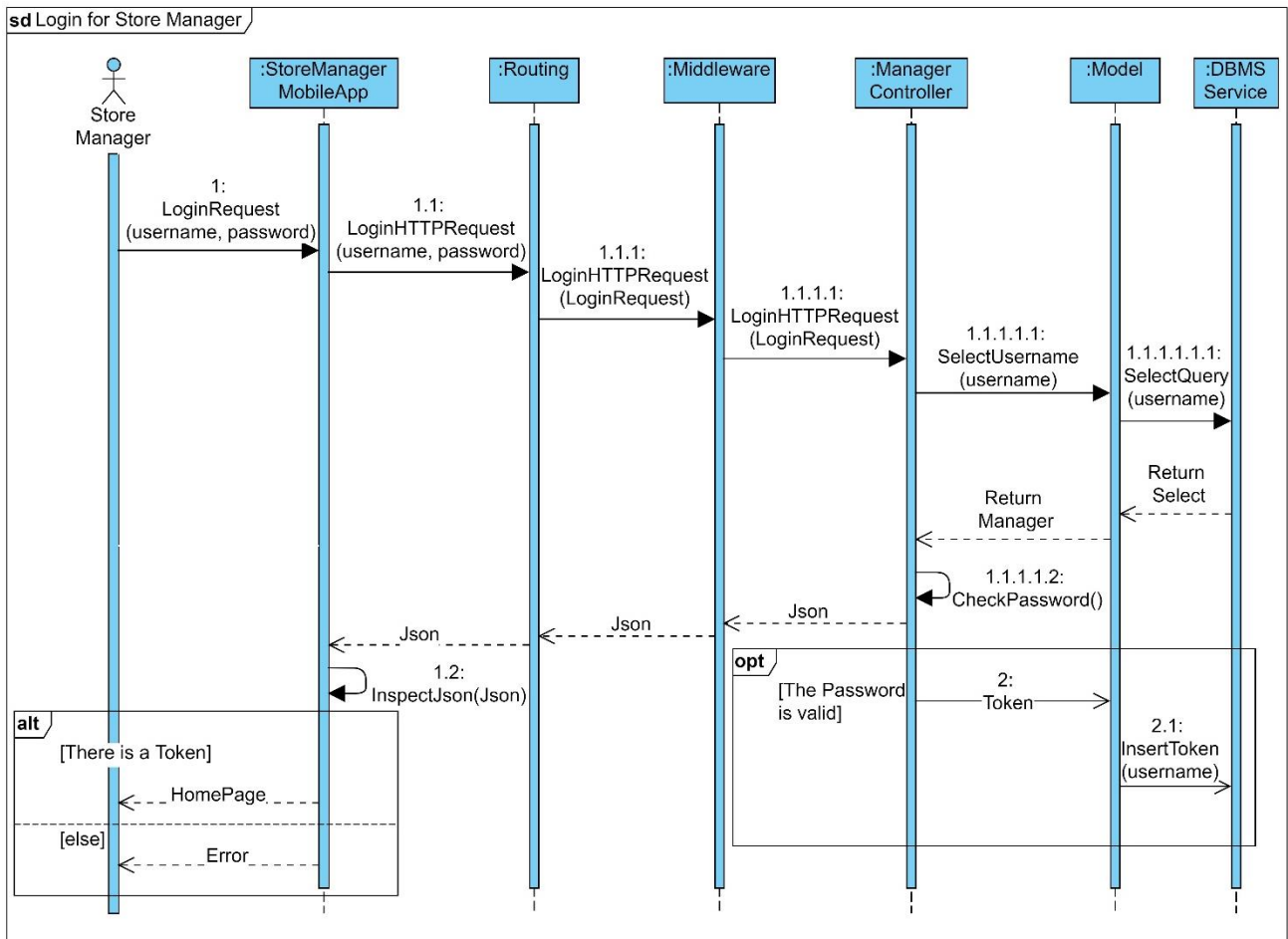
The above sequence diagram shows the login process for a generic customer.

First, the customers insert their credentials using the CustomerMobileApp and then they require the authentication. The application sends an HTTP request that is propagated through the Routing and the Middleware until it reaches the UserController. At this point, the controller requests the customer account data utilizing a query and the functionalities exposed by the Model. These data, returned at the UserController, are used to check the credentials inserted by the customers at the beginning.

If the credentials are correct, a token is generated, it is serialized in a JSON file, and it is returned at the CustomerMobileApp. Here the file is checked and, if there are no errors, the Home Page is displayed to the customers. At the same time, the token is propagated from the UserController to the DBMSService in order to be stored permanently in the database.

Otherwise, if the check generates an error, the JSON file contains the error itself. In this case, the CustomerMobileApp shows an error message to the customers.

2. Login for Store Manager



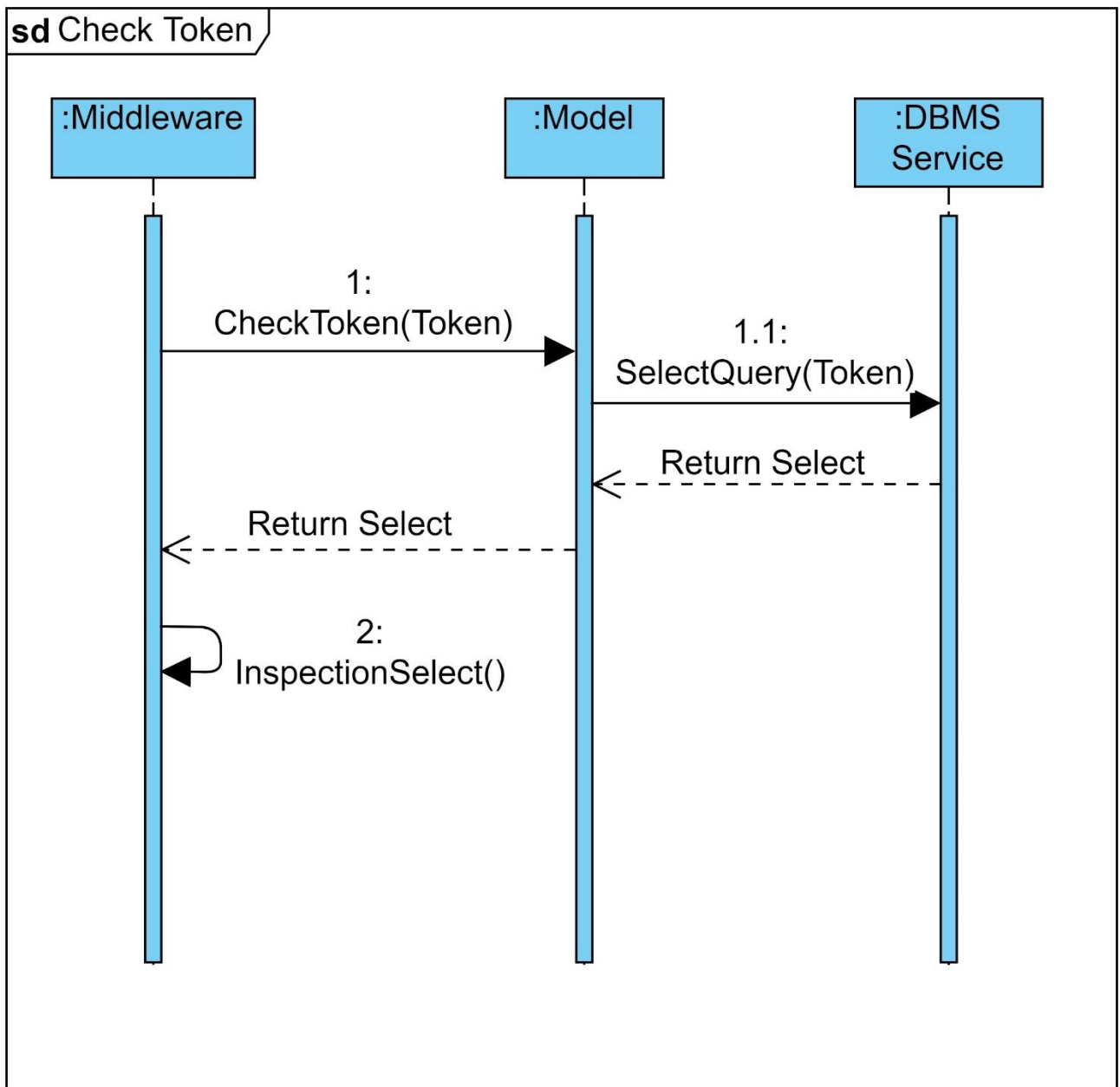
The above sequence diagram shows the login process for the store manager. It is quite similar to the previous one with some differences.

First, the store managers insert their credentials using the StoreManagerMobileApp requiring the authentication. Then, the application sends an HTTP request that is propagated through the Routing and the Middleware until it reaches the ManagerController. At this point, the controller requests the store manager account data utilizing a query and the functionalities exposed by the Model. These data, returned at the ManagerController, are used to check the credentials inserted by the store managers at the beginning.

If the credentials are correct, a token is generated, it is serialized in a JSON file, and it is returned at the StoreManagerMobileApp. Here the file is checked and, if there are no errors, the Home Page is displayed to the managers. At the same time, the token is propagated from the StoreManagerController to the DBMSService in order to be stored permanently in the database.

Otherwise, if the check generates an error, the JSON file contains the error itself. In this case, the StoreManagerMobileApp shows an error message to the managers.

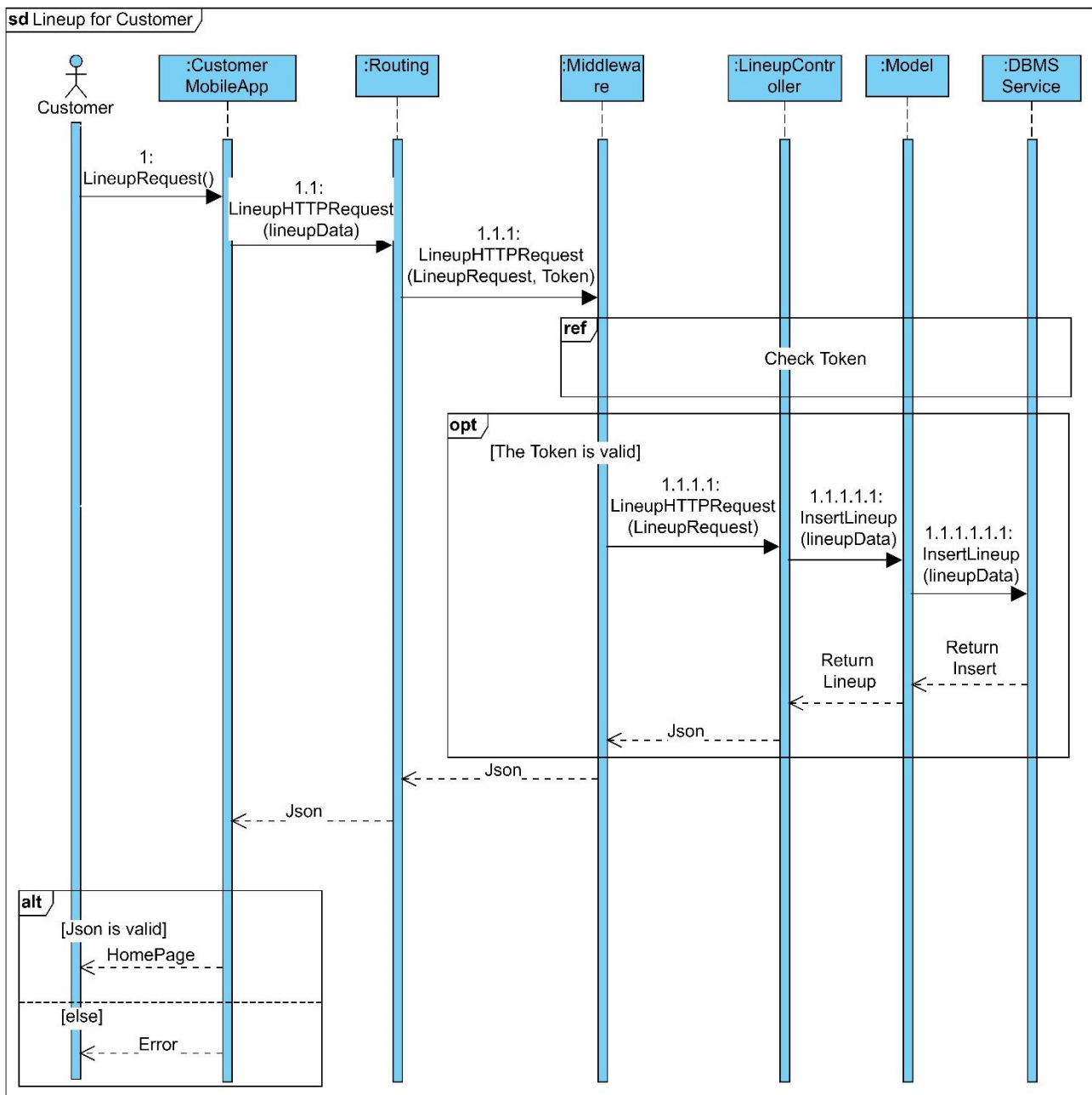
3. Check Token



This sequence will be used in the next diagrams. In particular, the diagram shows the process of checking the token to authorize the actions required by the users. If the token is not valid, the requests are not forwarded by the Middleware.

First, the Middleware calls a method of the Model passing as a parameter the token itself. This token is then used in a query that is executed by the DBMSService. Following the same path, the result arrives at the Middleware where it is inspected.

4. Lineup for Customer



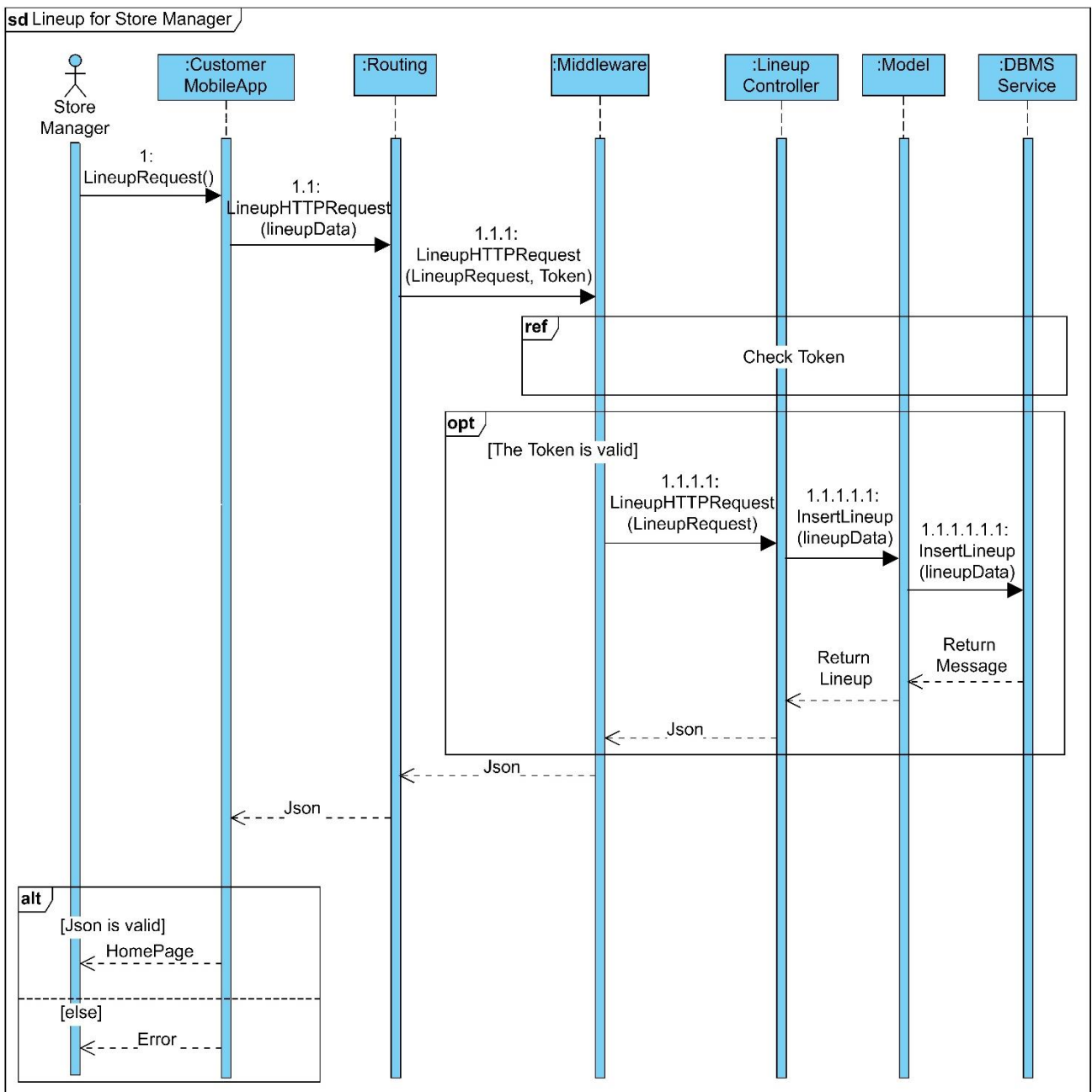
The diagram in this section displays the Lineup sequence for customers.

As usual, the customer requires the action to the CustomerMobileApp. Then, the application sends an HTTP request that reaches the Middleware after has been passed through the Routing component. Here, the token is checked with the CheckToken sequence already described.

If the check is positive, then the request of lining up is propagated until the LineupController. The LineupController calls a method of the Model and then a query is executed in the DBMSService. Following the same path, the information about the Lineup is returned to the LineupController and serialized in a JSON that reaches, in the end, the CustomerMobileApp. Lastly, the application shows the Home Page with the updated list of reservations.

If the check is negative, the Middleware does not allow the forwarding of the request. So, an error message is serialized in the JSON file and it is sent to the CustomerMobileApp. In this case, the application displays an error page instead of the Home Page.

5. Lineup for Store Manager



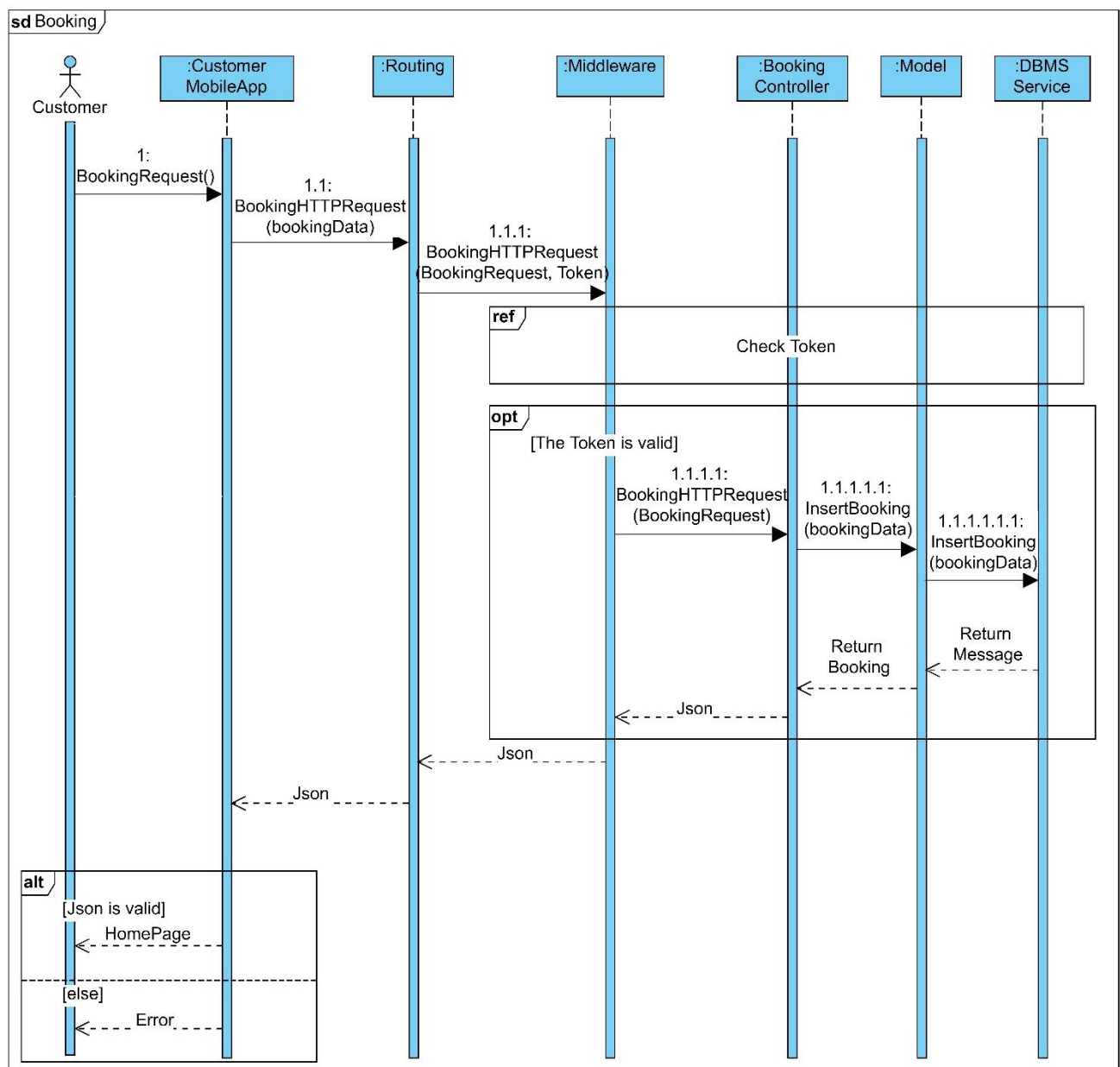
The diagram above depicts the Lineup sequence for store managers. It is quite similar to the one for customers with some differences.

As usual, the customer requires the action to the StoreManagerMobileApp. Then, the application sends an HTTP request that reaches the Middleware after has been passed through the Routing component. Here, the token is checked with the CheckToken sequence already described.

If the check is positive, then the request of lining up is propagated until the LineupController. The LineupController calls a method of the Model and then a query is executed in the DBMSService. Following the same path, the information about the Lineup is returned to the LineupController and serialized in a JSON that reaches, in the end, the StoreManagerMobileApp. Lastly, the application shows the Home Page.

If the check is negative, the Middleware does not allow the forwarding of the request. So, an error message is serialized in the JSON file and it is sent to the StoreManagerMobileApp. In this case, the application displays an error page instead of the Home Page with the updated list of reservations.

6. Booking



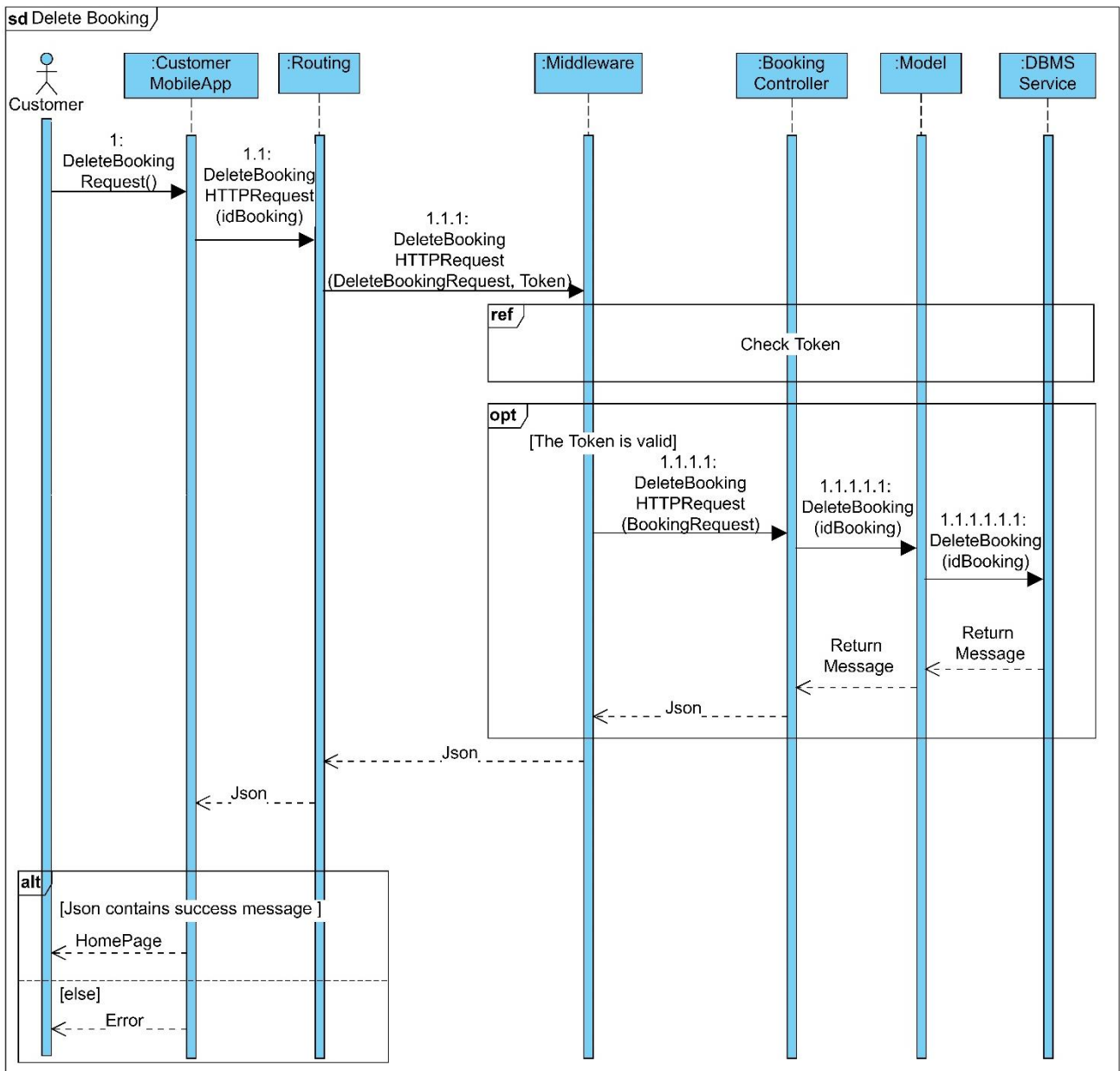
The diagram above shows the Booking sequence that is allowed only for customers.

The interested customer uses the CustomerMobileApp to get a new booking. The CustomerMobileApp sends an HTTP Request that passes through the Routing and arrives at the Middleware. Here, the token is checked with the CheckToken sequence already described.

If the token is valid, then the booking request is propagated until the BookingController. The BookingController calls a method of the Model and then a query is executed in the DBMSService. The ack and the information about the booking are returned to the BookingController and then it is serialized in a JSON file. This file then reaches the CustomerMobileApp where it is checked. The CustomerMobileApp shows, in the end, the HomePage with the updated list of reservations.

If the token is not valid, the Middleware does not forward the request. Next, an error message is serialized in the JSON file, it is sent to the CustomerMobileApp, and the application displays an error page instead of the Home Page.

7. Delete Booking



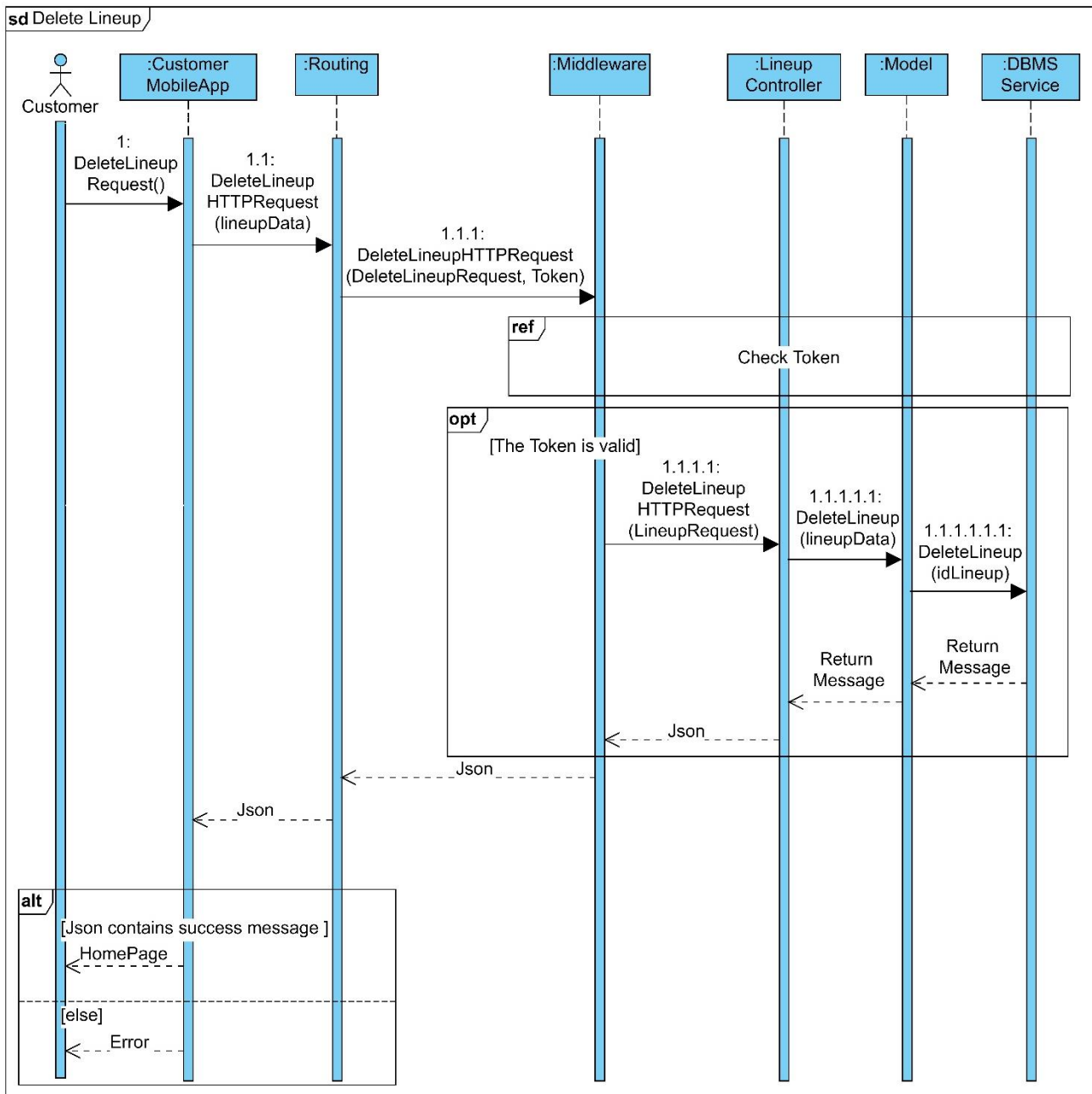
The sequence diagram above shows the process of deleting a customer's booking.

First, customers require the operation using the CustomerMobileApp that, then, sends an HTTP request. This request passes through the Routing and the Middleware where the token is checked as described before.

If the token is valid, the HTTP request can be delivered to the Booking Controller that calls a method of the Model. Then, a query is executed in the DBMSService. A message that contains an ack about the request is backpropagated until the BookingController where it is serialized in a JSON file. This file traverses the Middleware and the Routing and arrives at the CustomerMobileApp. Here the Home Page and the updated list of active reservations are shown.

If the token is not valid the JSON contains an error message. Due to this, the CustomerMobileApp shows an error message too.

8. Delete Lineup for Customer



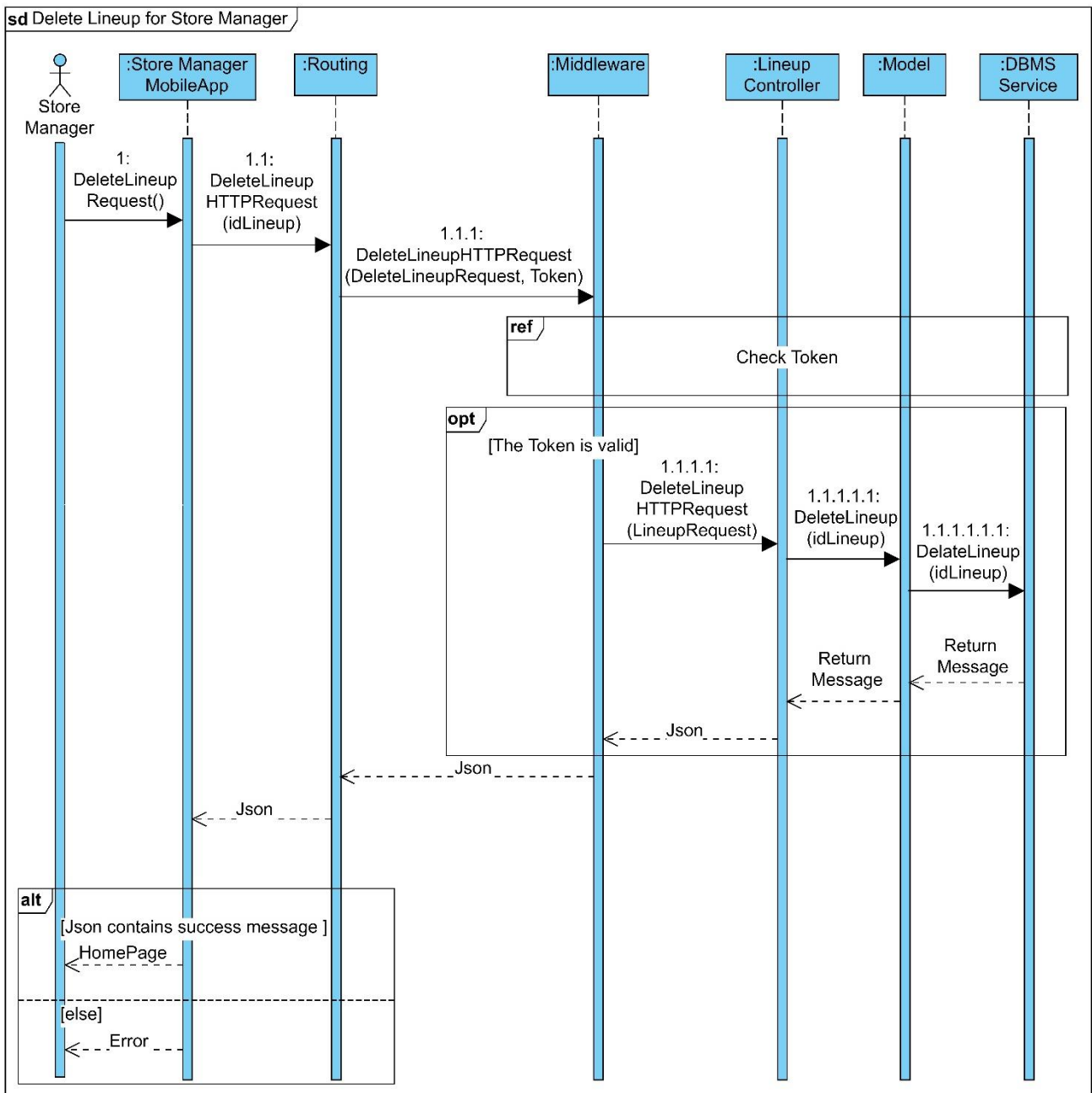
The sequence diagram depicts the phases of deleting a customer's lining up.

The customer requires the deleting by means of the CustomerMobileApp. This one sends an HTTP request that passes through the Routing and the Middleware. Here the token is checked as described before.

If the token is valid, the HTTP request can be forwarded until the Lineup Controller where a method of the Model is called. Then, a query is executed in the DBMSService. An ack message is backpropagated until the LineupController where it is serialized in a JSON file. The JSON arrives at the CustomerMobileApp after it has been passed through the Middleware and the Routing. At this point, the Home Page and the updated list of active reservations are shown to the customer.

If the token is not valid, then the JSON contains an error message. Due to this, the CustomerMobileApp shows an error message instead of the HomePage.

9. Delete Lineup for Store Manager



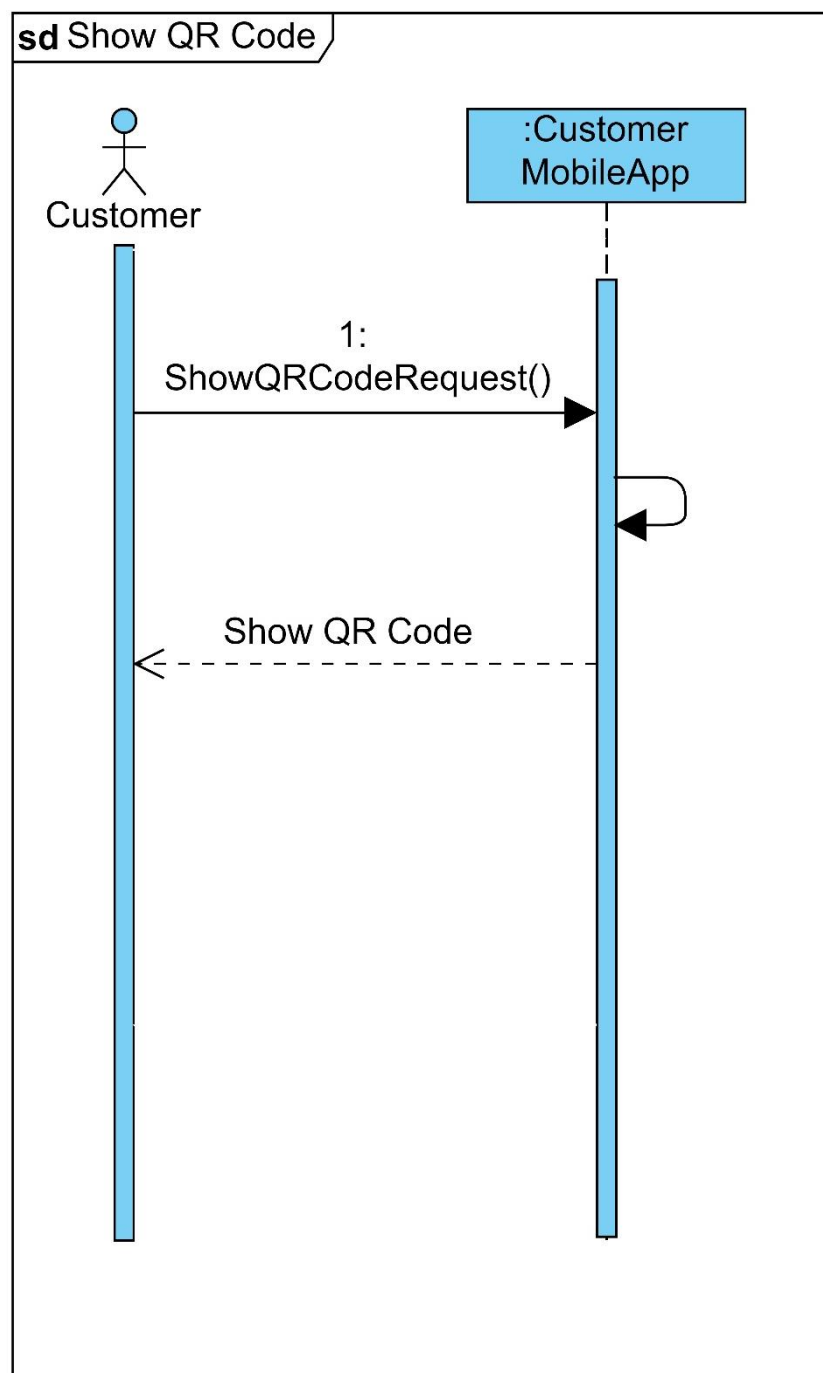
The sequence diagram shows the deleting of a store manager's lining up. The phases are similar to what is already shown for the customer's lineup deleting operation.

The store manager requires the deleting by means of the StoreManagerMobileApp. This one sends an HTTP request that passes through the Routing and the Middleware. Here the token is checked as described before.

If the token is valid, the HTTP request can be forwarded until the Lineup Controller where a method of the Model is called. Then, a query is executed in the DBMSService. An ack message is backpropagated until the LineupController where it is serialized in a JSON file. The JSON arrives at the StoreManagerMobileApp after it has been passed through the Middleware and the Routing. At this point, the Home Page and the updated list of active reservations are shown to the store manager.

If the token is not valid, then the JSON contains an error message. Due to this, the StoreManagerMobileApp shows an error message instead of the HomePage.

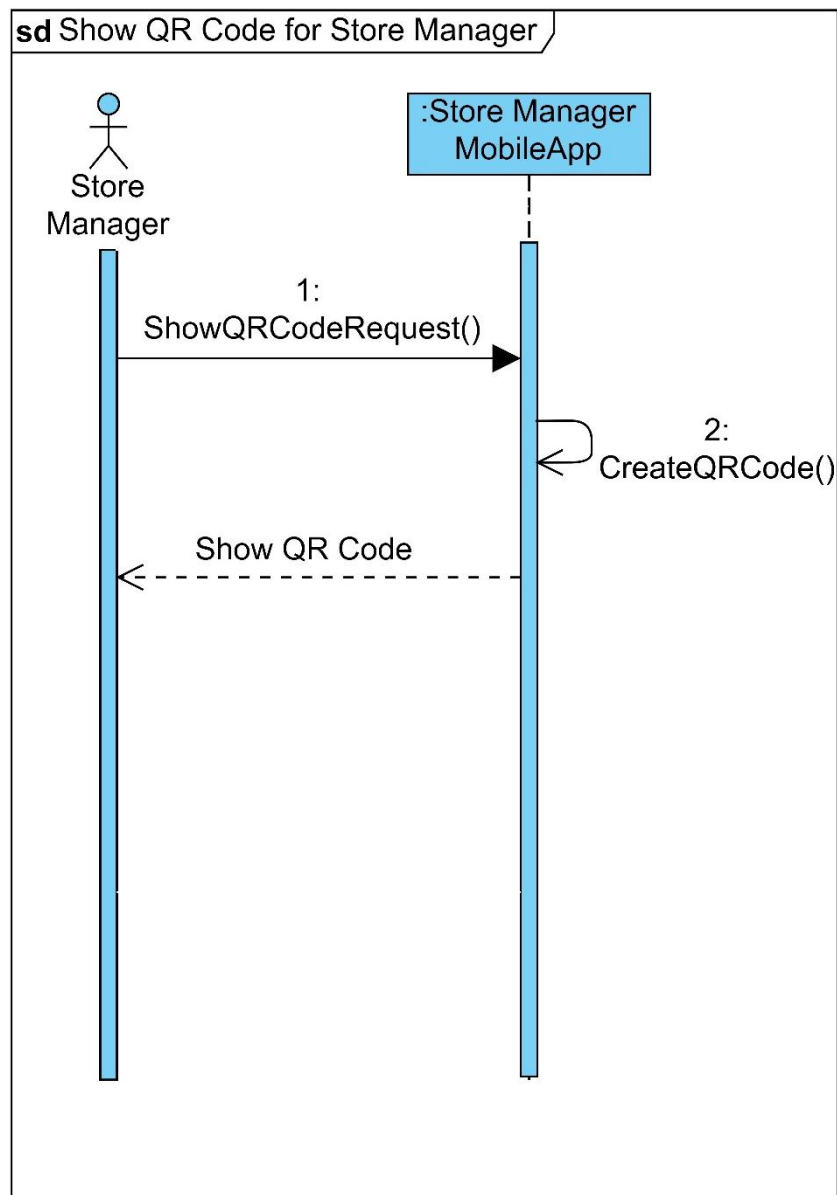
10. Show QR Code for Customer



The diagram shows the phases that allow the system to show the QR Code associated with a specific reservation at a customer. This code can be also printed by the customer.

The request is satisfied entirely on the side of the CustomerMobileApp. First, the customer requests the QR Code using the dedicated functionalities of the application. Then, the CustomerMobileApp generates the code and shows it.

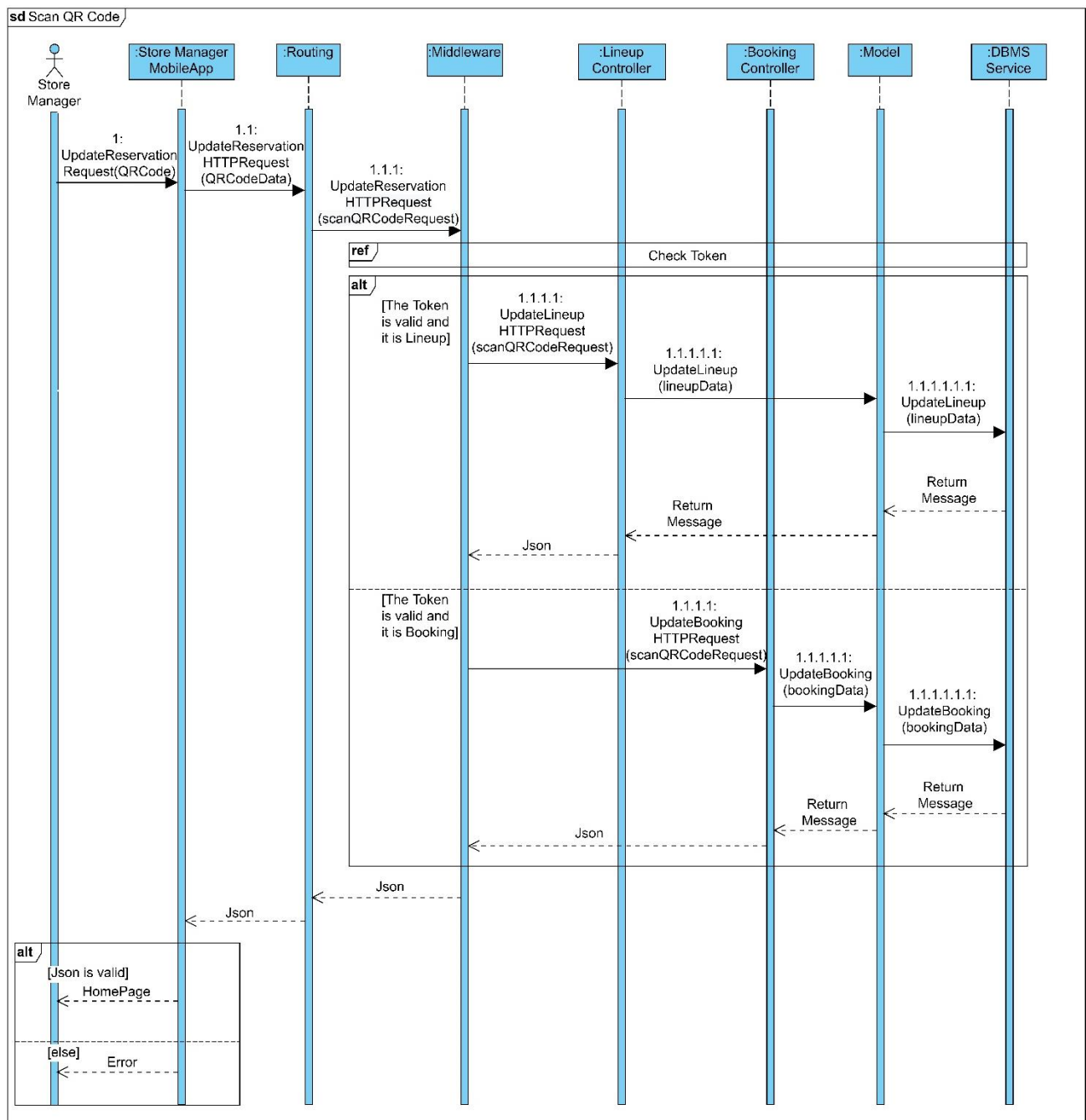
11. Show QR Code for Store Manager



The diagram shows the phases that allow the store manager to view, check, and print the QR Code.

The request is satisfied entirely on the StoreManagerMobileApp side. First, the store manager uses the dedicated functionalities of the application to require the QR code. Then, the StoreManagerMobileApp generates the code and shows it.

12. Scan QR Code



The sequence above depicts the operation of scanning a QR code performed by the store manager to allow customers to enter and exit the store.

As usual, the store manager selects the functionality on the StoreManagerMobileApp. Then the HTTP request is propagated across Routing and Middleware and the checks on the token are done.

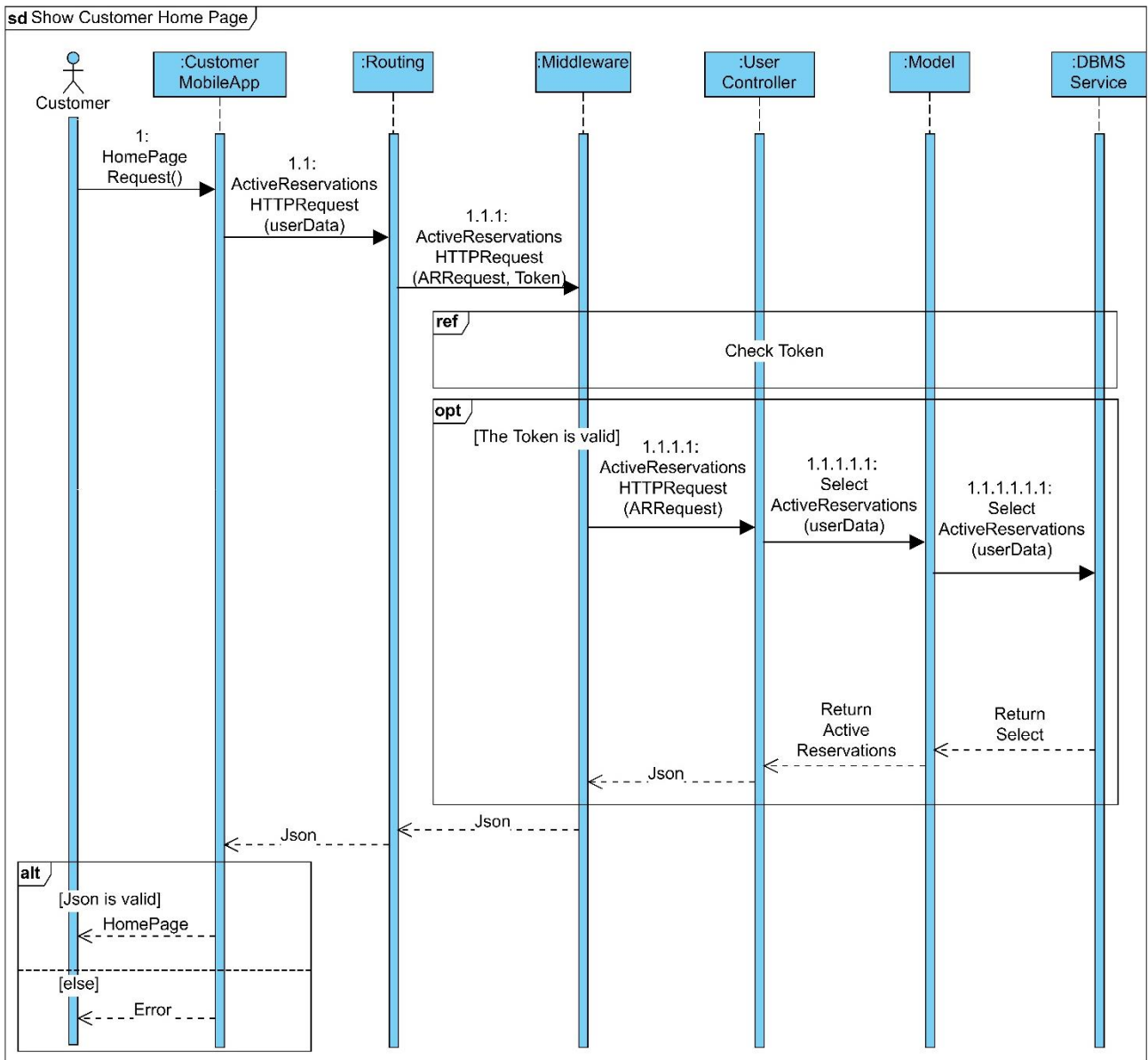
If the token is valid, we have two possibilities.

In the first, the QR code is associated with a lining up, so the request is propagated at the LineupController. Later, a suitable method of the Model is called and an update is done on the database-side. An ack message is returned with some information about the new reservation that is serialized in a JSON file by the LineupController. When this file has arrived at the StoreManagerMobileApp and has been checked, the HomePage is shown.

The second possibility happens when the QR code is associated with a booking. In this case, the previous operations are done referring to the BookingController. So, it calls a method of the Model and the update is required at the DBMS. Then, the information is returned and it is serialized in the JSON file by the BookingController. The file arrives at the StoreManagerMobileApp, it is checked and the HomePage is shown.

Otherwise, if the token is not valid, the reservation request is not propagated and the JSON contains an error message. This message is read by the StoreManagerMobileApp that shows an error message at the store manager.

13. Show Customer Home Page



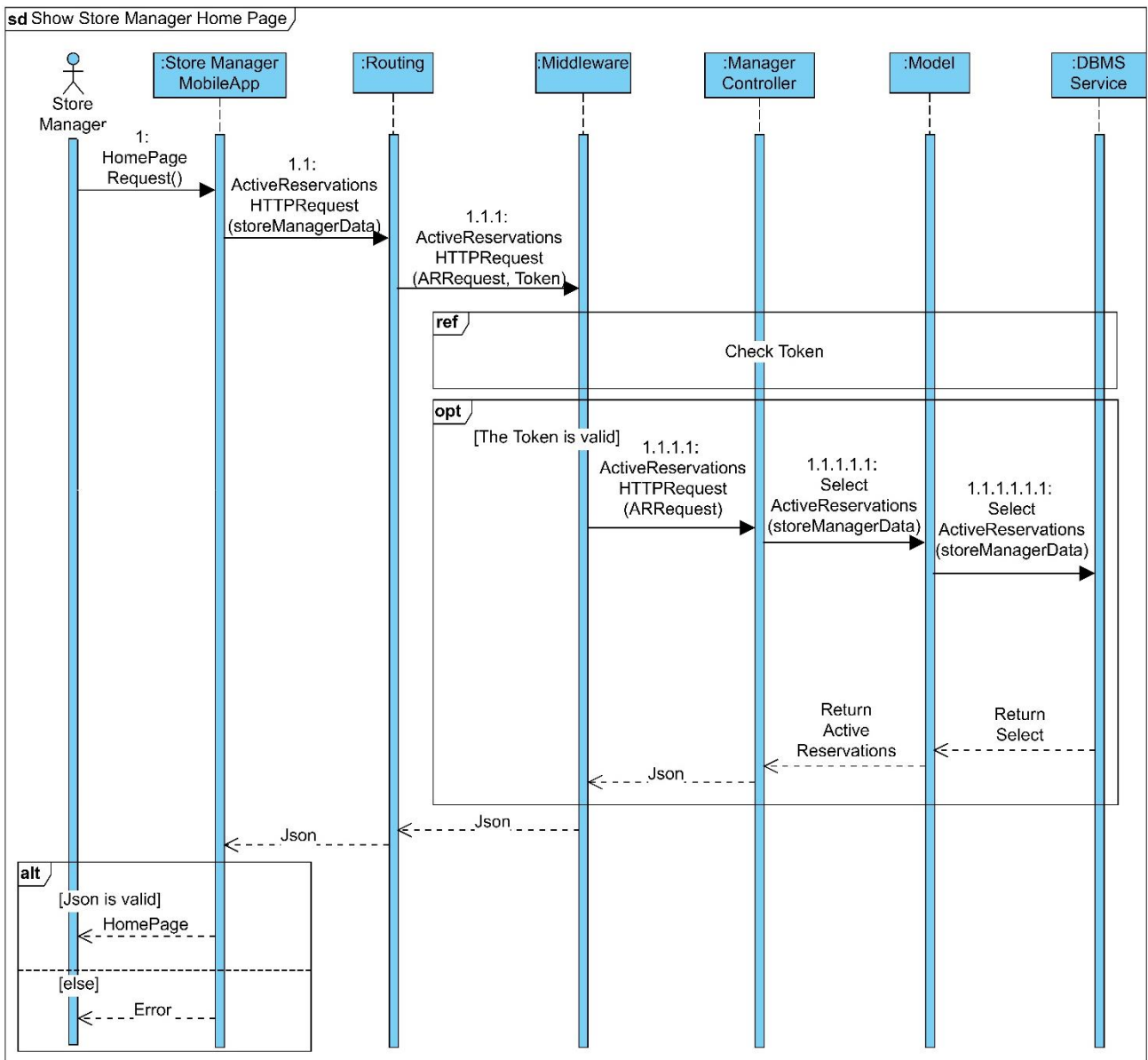
This sequence diagram shows the process that permits the visualization of the Home Page and its information by the customer.

The customer selects the section Home Page in the Customer Mobile App. This page, as specified in the RASD, contains the list of active reservations. So, the correlated HTTP request is passed to the Routing and the Middleware where the authentication token is checked.

If the token is valid, the request proceeds across User Controller and Model, and the select query is performed into the database. The result of the select operation is returned to the model first, and the Use Controller then. Here, the active reservations are serialized in a JSON file that is propagated through the Middleware and the Routing until the Customer Mobile App. Lastly, the Home Page with the list of the active reservations is displayed.

If the token is not valid, an error message is serialized and the request is not propagated. The Customer Mobile App shows an error message too.

14. Show Store Manager Home Page



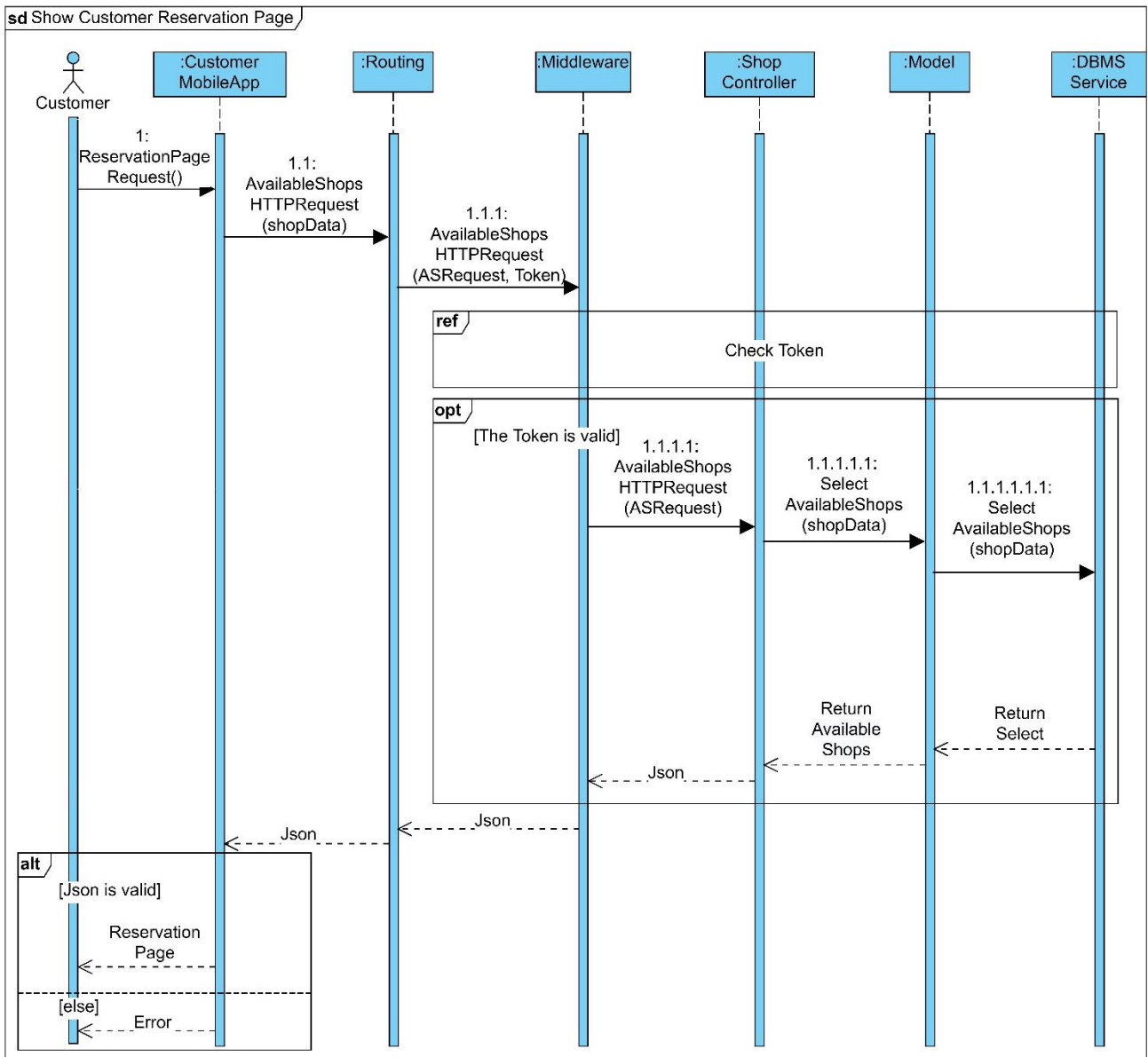
This sequence diagram shows the process that allows the visualization of the HomePage and its information by the store manager.

The store manager selects the HomePage in the StoreManagerMobileApp. This page, as specified in the RASD, contains the list of active reservations. So, the correlated HTTP request is passed to the Routing and the Middleware where the authentication token is checked.

If the token is valid, the request proceeds across ManagerController and Model, and the select query is performed into the database. The result of the select operation is returned to the model first, and the ManagerController then. Here, the active reservations are serialized in a JSON file that is propagated through the Middleware and the Routing until the StoreManagerMobileApp. Lastly, the HomePage with the list of the active reservations is displayed.

If the token is not valid, an error message is serialized and the request is not propagated. The StoreManagerMobileApp shows an error message too.

15. Show Customer Reservation Page



The sequence diagram explains the process to visualize the ReservatioPage with the list of the available shops to the customer.

The customer requires the page at the CustomerMobileApp. This one sends an HTTP request to the Routing component that is propagated to the Middleware where the token is checked.

If the token is valid, the request can proceed in direction of the ShopController. It calls a method of the Model and a query to obtain the list of the available shops is performed into the database. The result of the operation is returned to the ShopController across the Model. Here a JSON file containing the information is serialized and it is propagated through the Middleware and the Routing to achieve the CustomerMobileApp. This one shows the ReservationPage with the list of the available shops.

If the token is not valid, the request is not propagated and the JSON contains an error message. When it reaches the CustomerMobileApp, it shows an error message accordingly.

2.5 Component interfaces

- **Smartphone:** suitable mobile device with an internet connection. Initially, the compatibility will be limited to the Android operating system.
- **Application Server:** it contains most of the application logic of the system.
- **DBMS:** MySQL. It is a Relational Database Management System (RDBMS) released with a system of double license (GNU GPL and commercial license). Its strengths include high availability and performance, and good scalability. It allows dealing with the common CRUD (Create Read Update Delete) operations.

2.6 Selected architectural styles and patterns

The system is based on a three-tier architecture, which is an architecture style composed of three main parts: presentation tier, application tier, and data tier. In more details:

- the **presentation tier** is represented by the CustomerMobileApp and StoreManagerMobileApp;
- the **application tier** includes the Routing, the Middleware, the various Controllers, and the Model;
- the **data tier** is composed of the database.

The choice is because the application should guarantee high reliability, high security, and high scalability.

As described in the previous sections of this document, the communication between the components on the client-side and the ones on the server-side is provided by means of HTTP requests.

Each controller can also serialize files in JSON format to return meaningful information to the CustomerMobileApp or StoreManagerMobileApp. This information might be the token used for the authentication, the confirmation and error messages (e.g. successful sign up), the data about the reservations (e.g. active reservations which are shown in the HomePage, history of reservations), and so on.

Moreover, the connection between the application and the server must be safe. For this purpose, it is used the TLS (*Transport Layer Security*) protocol and the needed SSL/TSL certificate.

Following two patterns on which the system is based.

Model View Controller (MVC)

The MVC is a pattern that permits a good level of decoupling of the code. It is applied by the definition of three distinct blocks:

- **Model:** allow to access and manage data through a series of methods. It is used by the controller;
- **View:** presents the data in a readable and understandable form for the user;
- **Controller:** takes the inputs and forward them to the Model after some operations like validation actions.

Singleton

A token is a unique string needed anytime the presentation tier wants to communicate with the application tier. This token and other user information that are useful for the presentation tier have to be stored in an object that has to be kept for the entirely CustomerMobileApp or StoreManagerMobileApp lifecycle. This pattern avoids the instantiation of this object in each view of the CustomerMobileApp and StoreManagerMobileApp that would be a very inefficient choice.

2.7 Other design decisions

2.8 Algorithms

2.8.1 Pseudocode

Each reservation is associated with a status. This status can assume three different values:

- **Wait:** the reservation is active and the customer is waiting for her/his shift;
- **Enter:** the customer is into the shop;
- **Exit:** the customer has left the shop and the reservation is not active anymore.

Following is shown the pseudocode that sketches the operation that the system has to do each time a customer leaves the shop.

```

1 ▾ if (Exit the store){
2 ▾   if(Is Booking?){
3     //change the status of the booking
4     booking.status=Exit;
5     //update the counter of current people into the store
6     counter--;
7   }
8 ▾   elseif(Is Lineup?){
9     //change the status of the lineup
10    lineup.status=Exit;
11    //update the counter of current people into the store
12    counter--;
13  }
14 }

```

Figure 3: Exit the Store - Pseudocode

Each time a customer exit the store, a new one takes her/his place. The following pseudocode illustrates the basic operations that manage this process. The ID of a reservation is a unique, incremental code, so it suffices to check this value to understand the order of entering. Capacity is the maximum number of people that can enter the store at the same time.

```

1 ▾ while (counter<capacity){
2 ▾   if(Is there a booking?) {
3     //select the minimum ID from the active bookings
4     getMinBookingID;
5     //authorize the booking to enter
6     booking.status=Enter;
7     //update the counter of current people into the store
8     counter++;
9   }
10 ▾   elseif(Is there a line up?) {
11     //select the minimum ID from the active lining ups
12     getMinLineUpID;
13     //authorize the lining up to enter
14     lineup.status=Enter;
15     //update the counter of current people into the store
16     counter++;
17   }
18 }

```

Figure 4: It is Your Turn - Pseudocode

Each reservation is associated with an estimation of the waiting time. The pseudocode above describes a possible sequence of operations for this purpose. The EnterTime indicates when the customer entered the store.

```

1 //initialization of the waiting time
2 waiting_time = 0;
3 //cycle on the active lining ups
4 for (Lineup with status==Wait){
5     //sum the current waiting time with the expected time associated to each lining
6     //up
7     waiting_time = waiting_time + lineup.expected_time;
8 }
9 //cycle on the active bookings whose timeslot is less or equal than the timeslot of
10 //the current reservation
11 for (Booking with status==Wait && booking.timeslot<=currentTimeSlot){
12     //sum the current waiting time with the expected time associated to each booking
13     waiting_time = waiting_time + booking.expected_time;
14 }
15 //cycle on the reservation with status equal to Enter (i.g. reservation associated
16 //to people into the store)
17 for (Reservation status==Enter){
18     //sum the current waiting time with the residual expected time
19     waiting_time = reservation.expected_time - (CurrentTimeStamp - EnterTime);
20 }

```

Figure 5: Waiting Time - Pseudocode

2.8.2 Flowcharts

Lastly, a series of flowcharts corresponding with the above pseudocode examples.

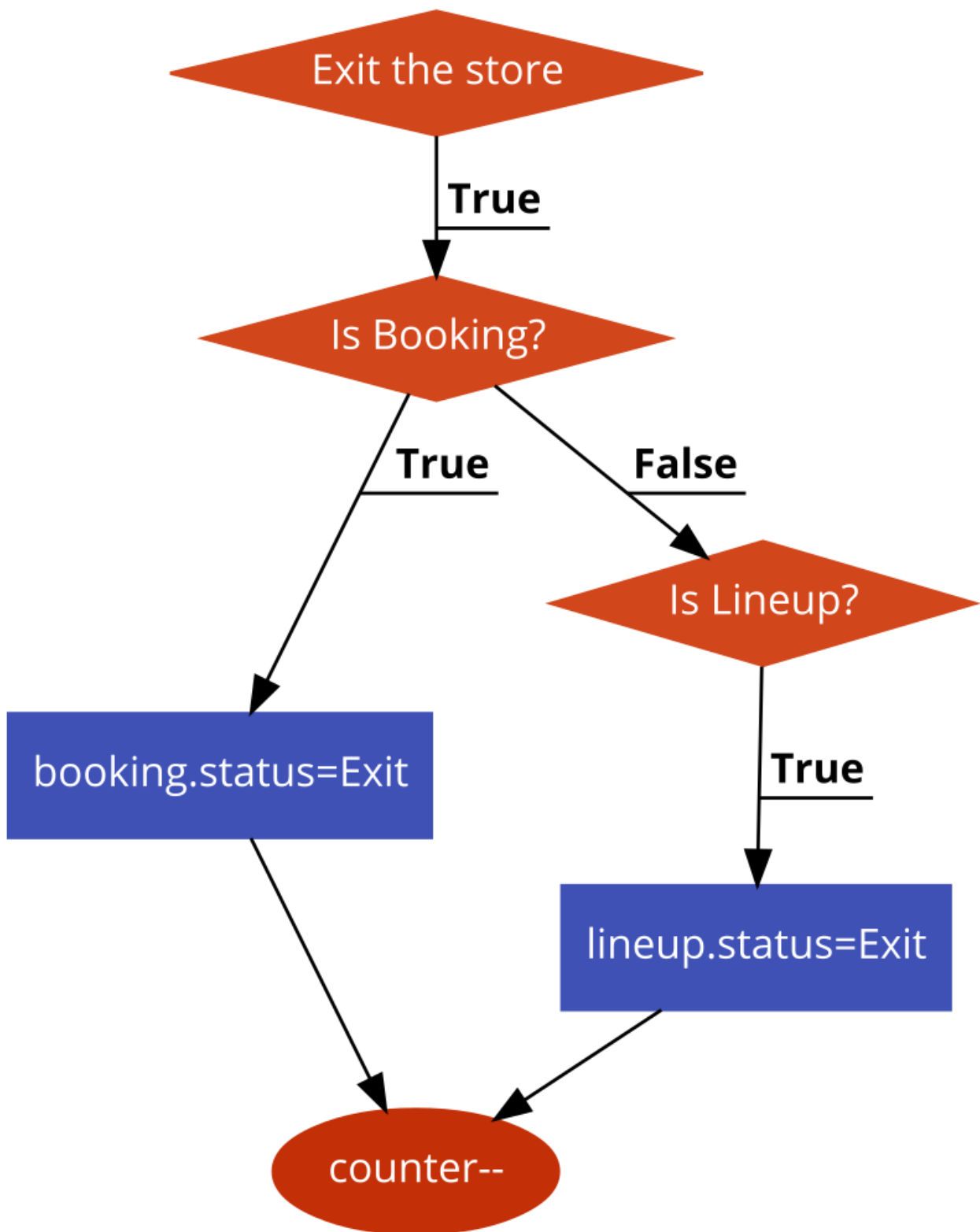


Figure 6: Exit the Store – Flowchart

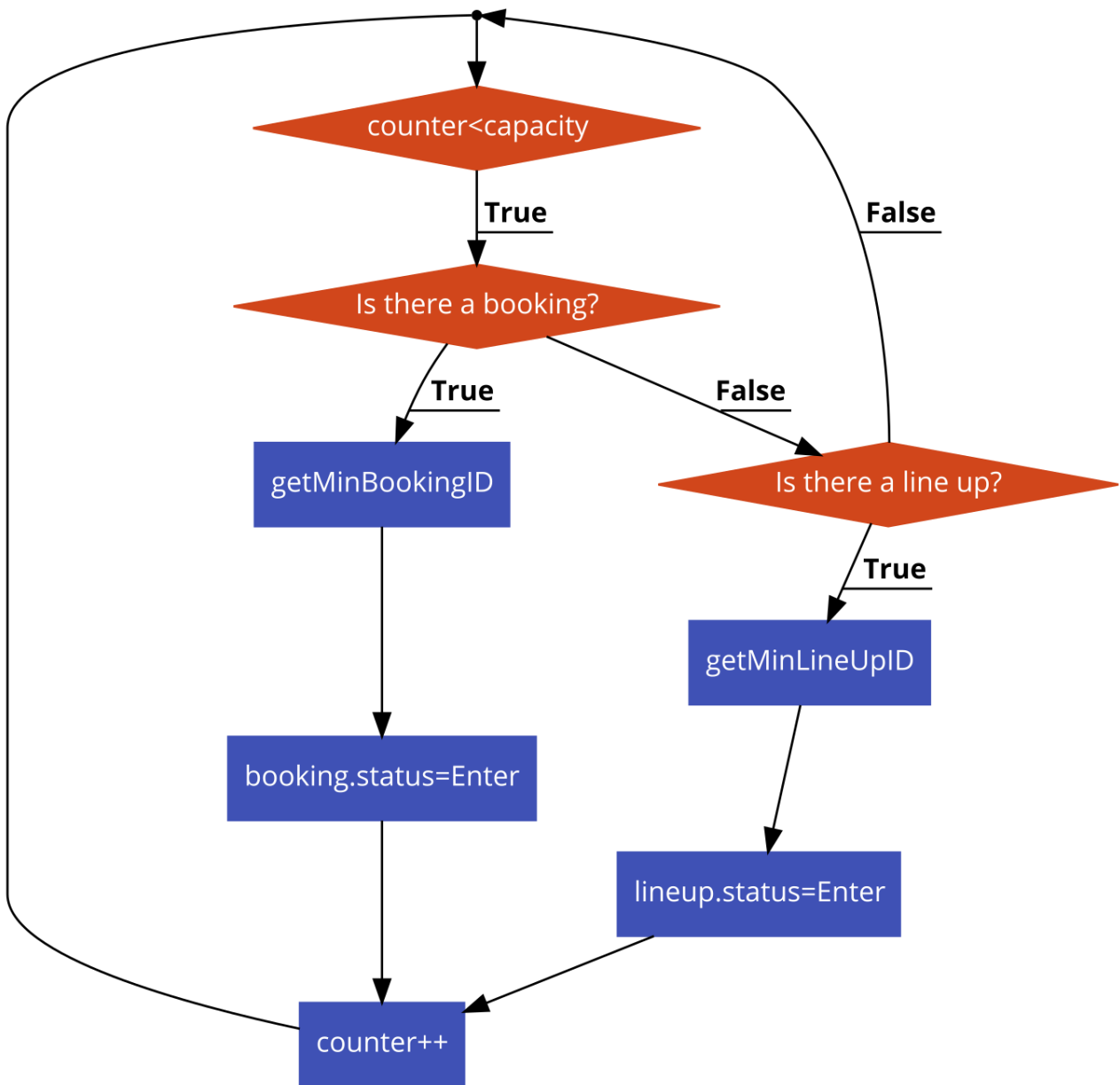


Figure 7: It is Your Turn – Flowchart

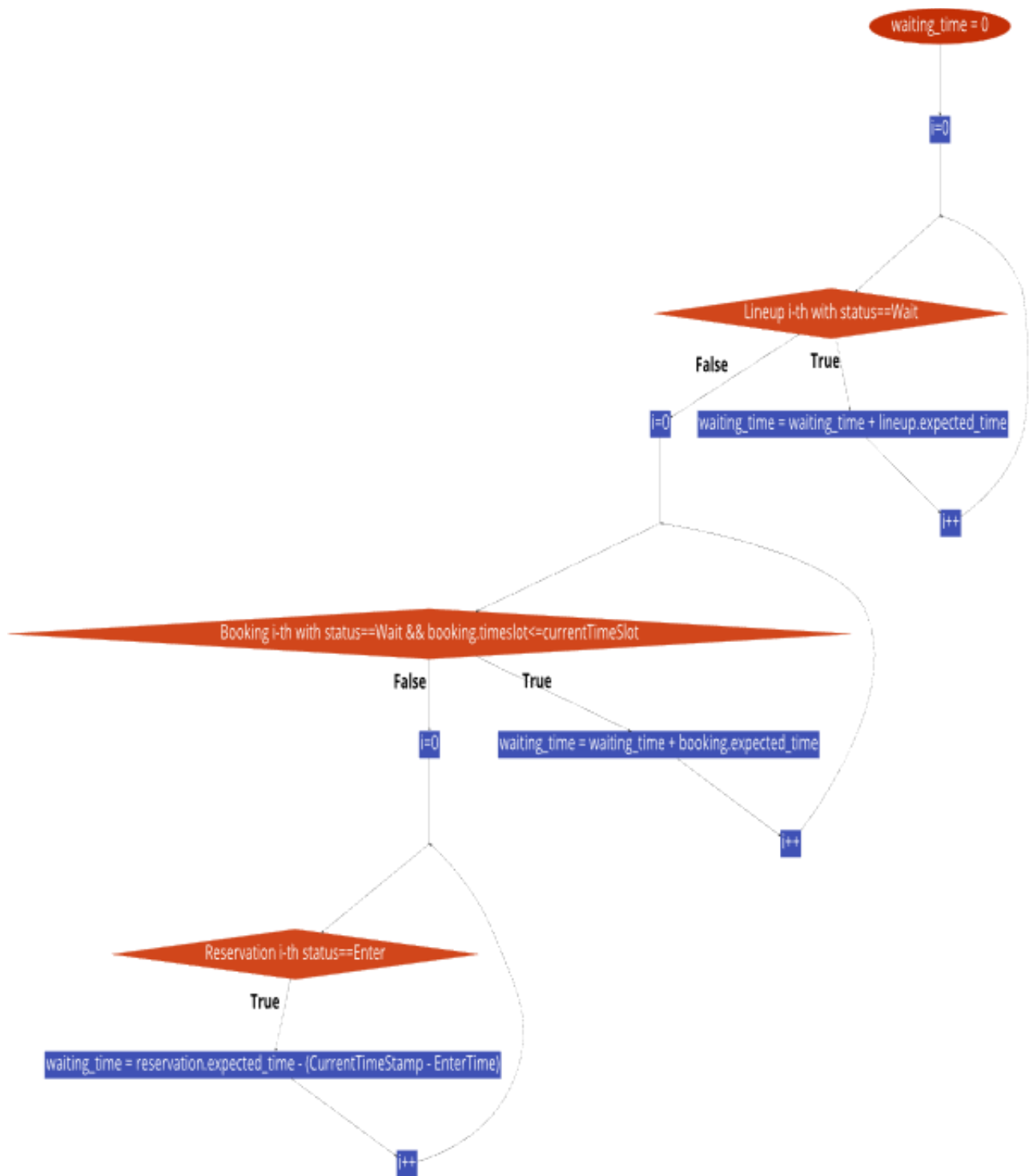


Figure 8: Waiting Time - Flowchart

3 USER INTERFACE DESIGN

In this section of the document, it is provided an overview of how the *User Interface* (UI) of the system will look like. Let us assume that the application is divided into several pages dedicated to the different main functionalities and that there are two versions of the application. One version is dedicated to the customers, while the other one is focused on the store manager. The following images show an idea of these pages.

3.1 Mock-up Customer Application



Figure 9: Customer Initial Page mock-up



Figure 10: Customer Login Page mock-up

Figure 1 represents the page that CLup shows to customers during their very first access. On this page, they are able to reach the Login Page if they are already registered to the platform or create a new account if it is the first time that they use the software.

Figure 2 illustrates the page that allows customers to insert their credentials and then access the functionality of CLup. The required credentials are the email and the password set during the Sign Up process.



Name

Insert here your name

Email

Insert here your email address

Password

Insert here your password

Repeat Password

Insert here your password again

SUBMIT

Figure 11: Customer Sign Up Page mock-up

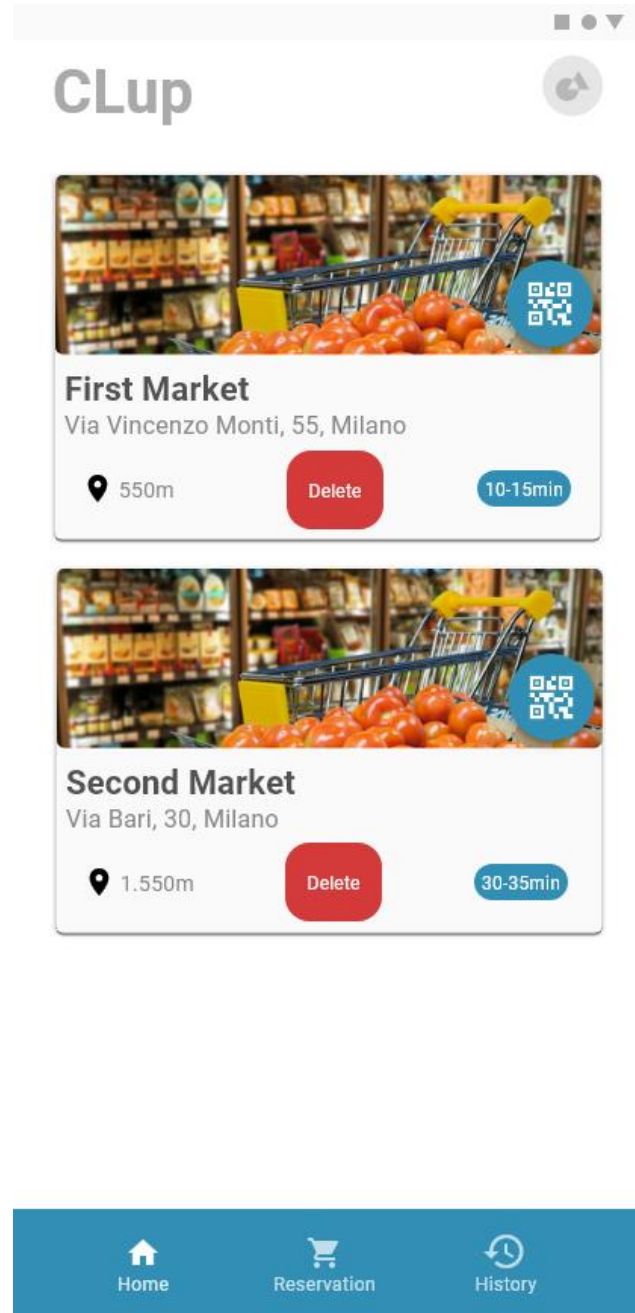


Figure 12: Customer Home Page mock-up

As anticipated before, customers can also submit their data and create a new account that allows access to the platform. The user profile is used to associate to each user the list of reservations (both active and non-active) and the duration of the previous visits to the stores used to improve the automatic estimation of the waiting time. An idea of the dedicated page is provided in Figure 3.

Due to the focus on privacy, the required data are only the essential ones. They are:

- Name
- Email
- Password
- Confirm password (to prevent typing mistakes)

Moreover, *Figure 4* depicts a mock-up of the Home Page of the application. It contains the main features like the list of active reservations with the possibility to delete them or to see the expected waiting time and some data about the shops. Furthermore, on this page, customers can open and use the QR code associated with each reservation.

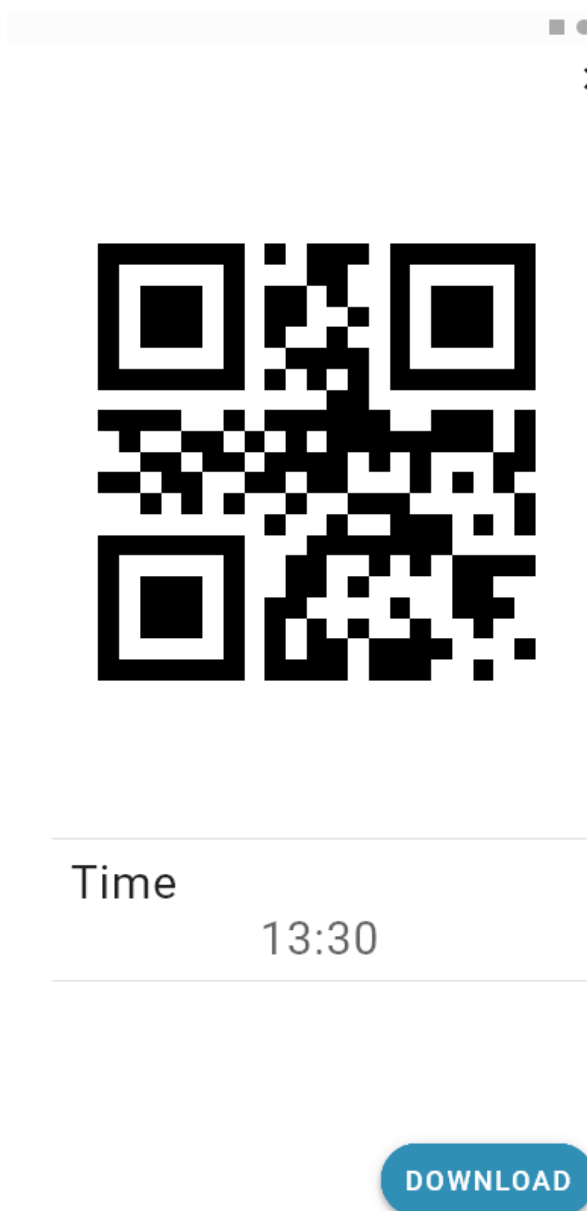


Figure 13: Customer QR Page mock-up

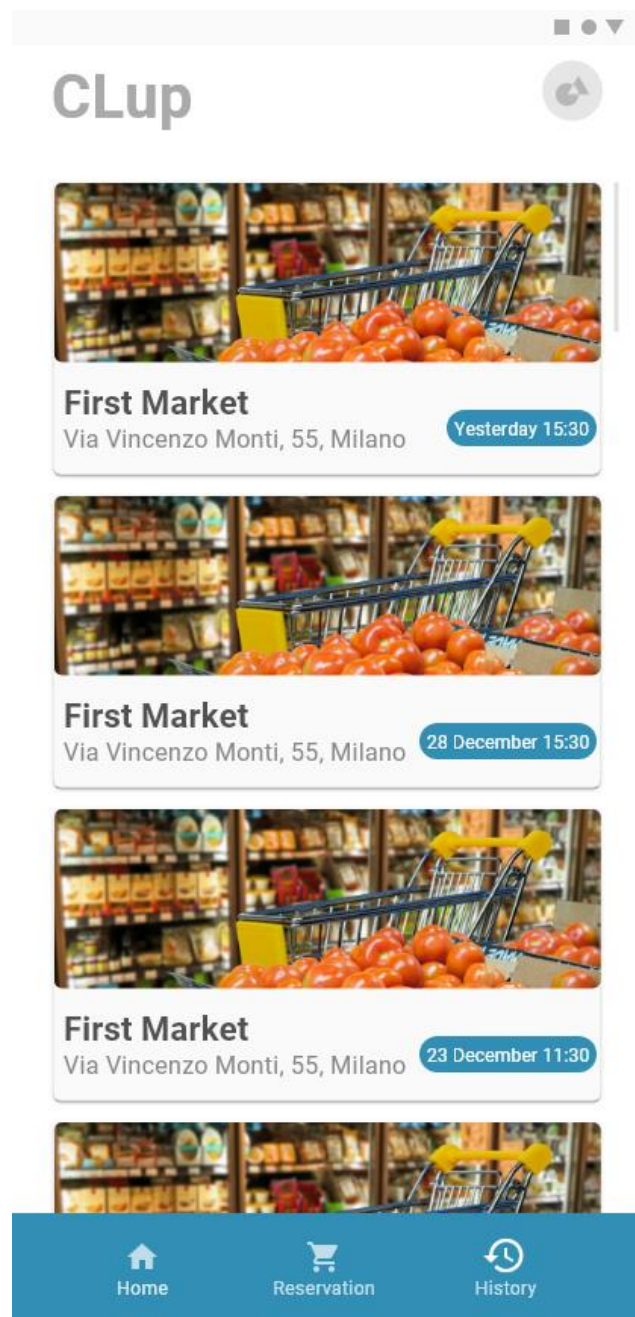


Figure 14: Customer History Page mock-up

On the left (*Figure 5*) a sketch of the page that shows the QR code associated with each reservation. Thanks to this page, the customers can scan their code when they enter and exit the store as expected. Here, it is provided also an indication of the expected waiting time or the expected time slot. Moreover, as specified during the phase of requirements definition, specific functionality is provided to allow downloading the QR code in the PDF format to make easier the printout.

On the right (*Figure 6*) it is shown a possible design of the History Page. Here, customers can access information about expired reservations with the indication of the shop (and its general data), the date and time of the reservation.

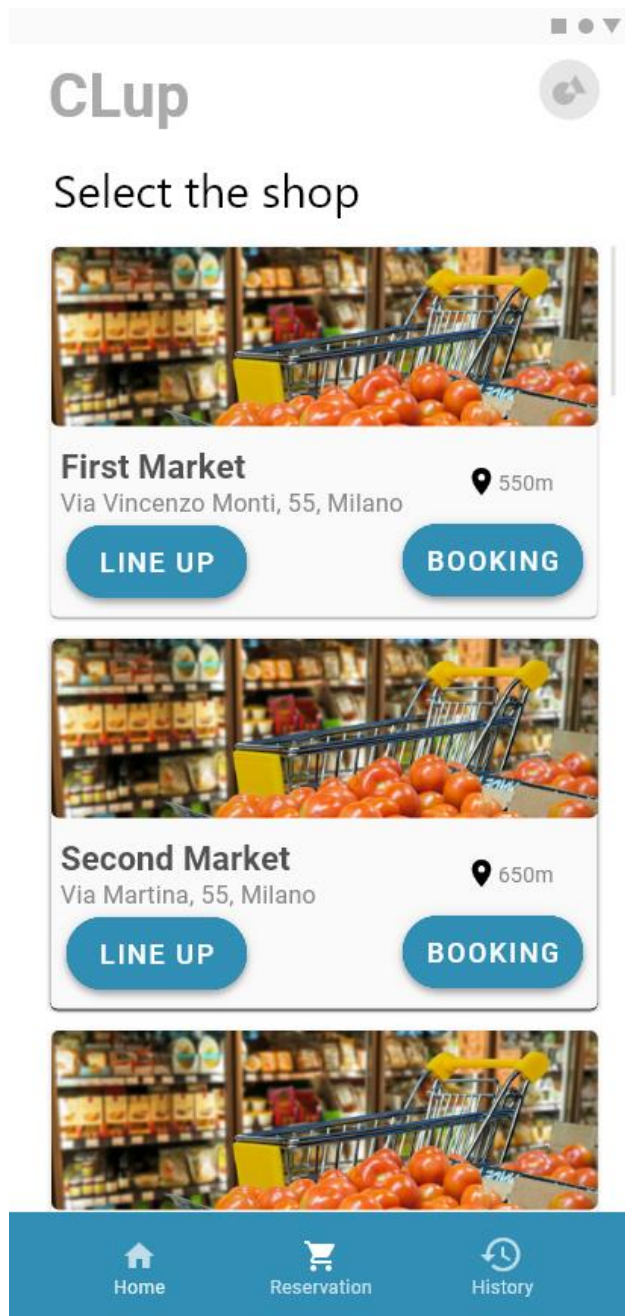


Figure 15: Customer Select Shop mock-up

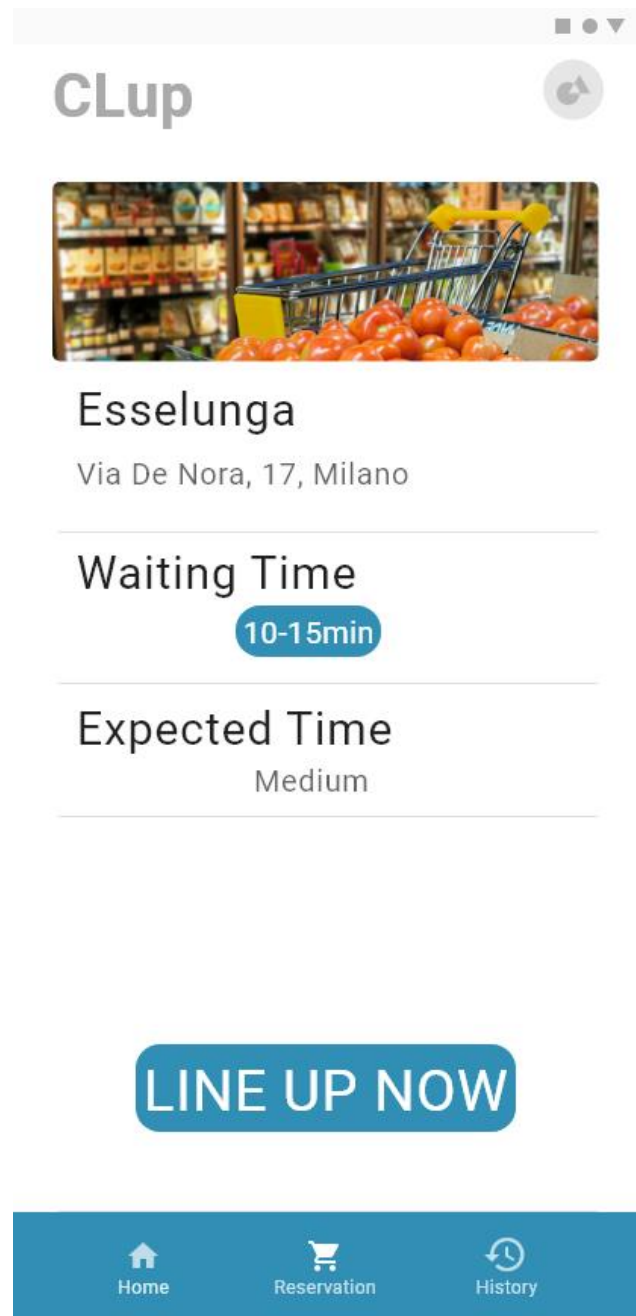


Figure 16: Customer Line Up Page mock-up

Figure 7 represents the Reservation Page that contains the list of active shops to permit customers to select the desired one. Each card of each store contains some information about the supermarket (e.g. position, photo) and the links to access lining up and booking functionalities.

Figure 8 shows the Line Up Page. Here, some information is provided like the name and position of the store and the expected waiting time. Moreover, customers must specify an estimation of the duration of the visit that is used by the system to better infer the waiting time.

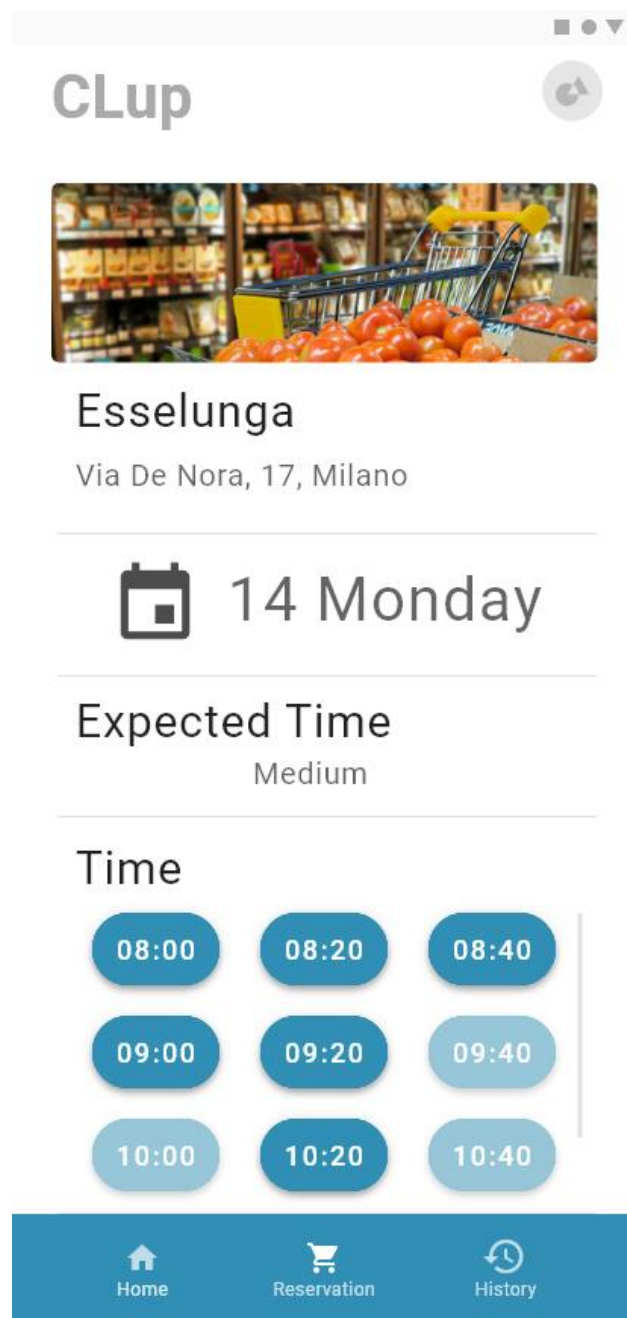


Figure 17: Customer Booking Page mock-up

Figure 9 gives a representation of how the Booking Page will look like. This page should contain the general data about the shop and allows to select the date and the time slot that is desired by the customer. Customers must also specify the expected duration of the visit.

3.2 Mock-up Store Manager Application



Figure 18: Store Manager Login Page mock-up

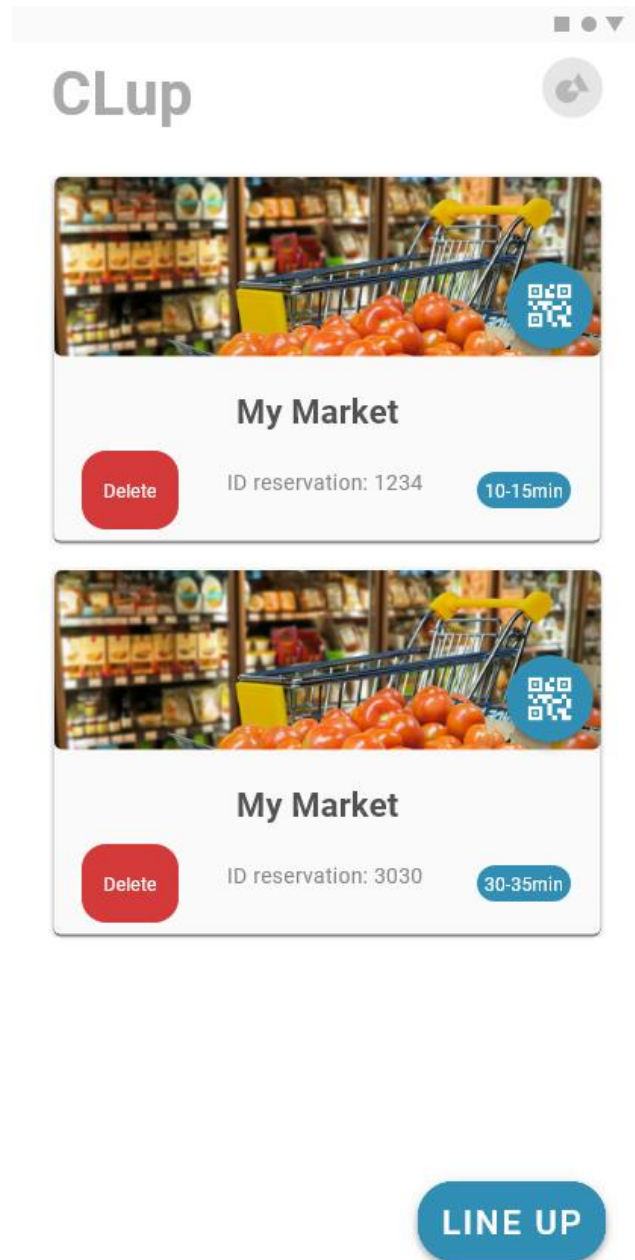


Figure 19: Store Manager Home Page mock-up

Figure 10 shows the version of the Login Page for Store Manager. In this case, the required credentials are the unique ID and the password.

On the other hand, Figure 11 depicts the Home Page of the application dedicated to store managers. This page contains some functionalities already seen in the version for customers like the possibility to delete a lining up and to check the expected waiting time. Moreover, in this version, the page contains also a direct link to the Line Up Page and an indication of the identifier of each reservation. This identifier is printed with the QR code and delivered to the customer and is used to associate each Line Up to each customer without requires her/his data (e.g. name). Lastly, on this page, store managers can open and print the QR code associated with each lining up.

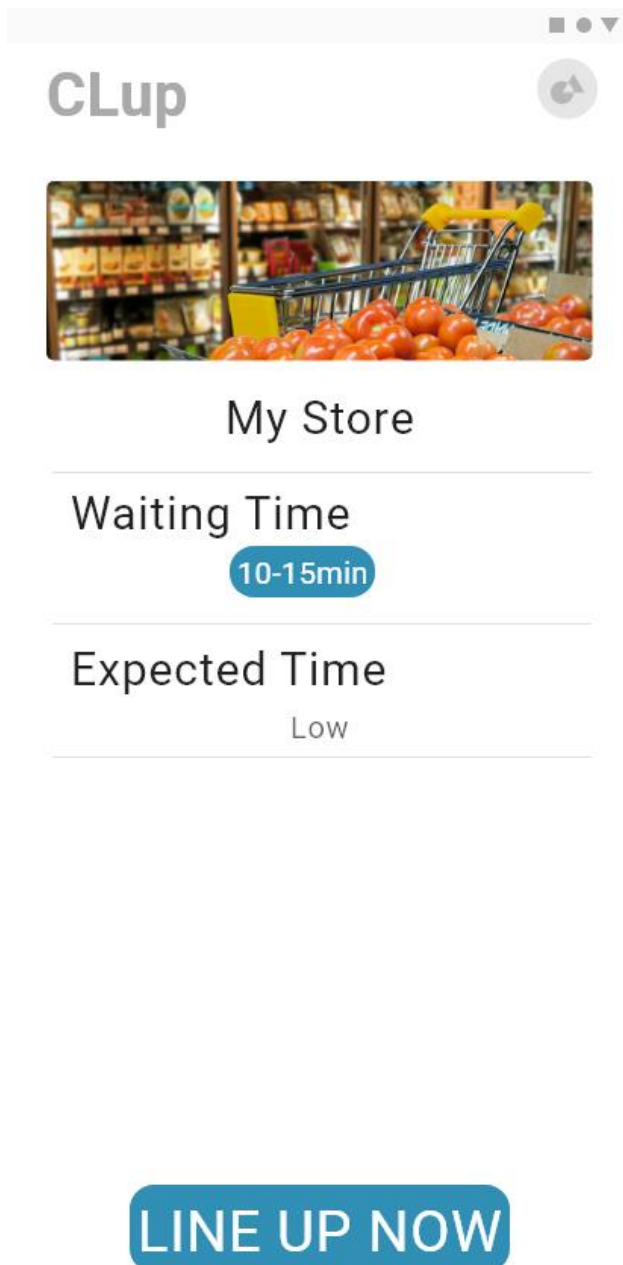


Figure 20: Store Manager Line Up Page mock-up

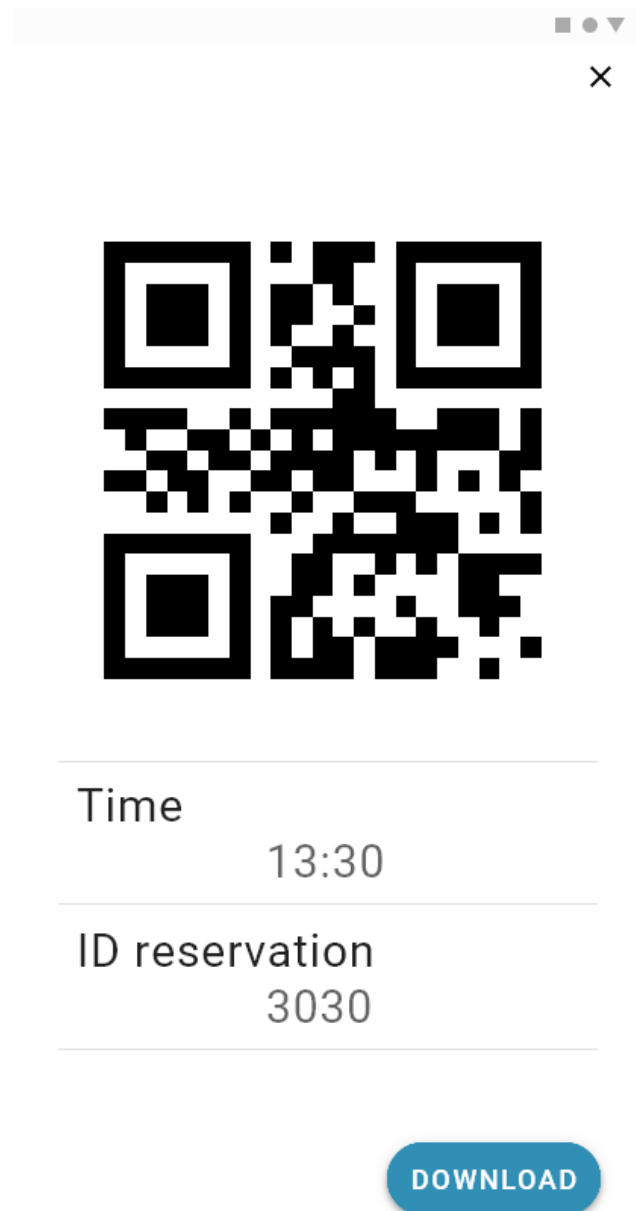


Figure 21: Store Manager QR Page mock-up

On the left (Figure 12) the Line Up Page. Here, the information about the waiting time is provided. Moreover, the page requires an estimation of the duration of the visit that is used by the system to better infer the waiting time.

On the right (Figure 13) an idea of the QR Page associated with each reservation. Thanks to this page, the store manager can provide the customer with an indication of the ID reservation and the estimated time. Furthermore, it is given the possibility to download the QR code in PDF format to make easier the printout.

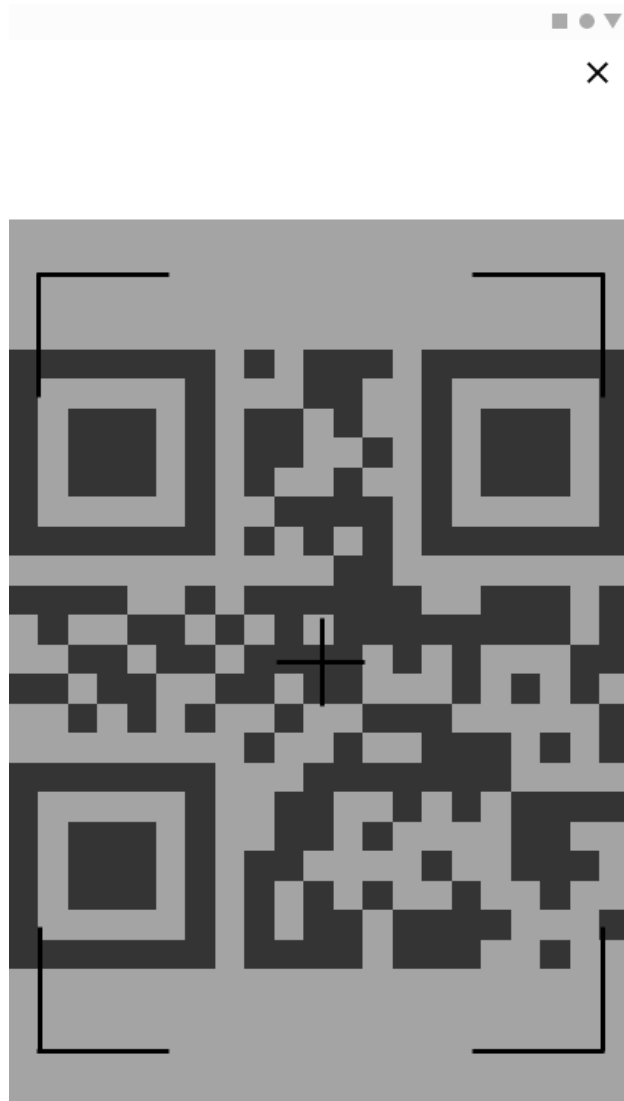


Figure 22: Store Manager QR Scanner Page mock-up

Figure 14 represents a possible UI of the QR code scanner. The store manager can scan the QR code shown by the customer to authorize the entering to or the exit from the store.

4 REQUIREMENTS TRACEABILITY

In this section, it is provided the mapping between the requirements defined in the RASD document and the components defined above. First, it is provided a general overview that gives the possibility to verify that all requirements are satisfied with the described components. Then, a more detailed analysis is presented.

ID	COMPONENT
C.1	Customer Mobile App
C.2	Store Manager Mobile App
C.3	Routing
C.4	Middleware
C.5	UserController
C.6	BookingController
C.7	LineupController
C.8	ShopController
C.9	ManagerController
C.10	Query Builder
C.11	Model
C.12	DBMSService

	C.1	C.2	C.3	C.4	C.5	C.6	C.7	C.8	C.9	C.10	C.11	C.12
R.1	X	X										
R.2	X	X	X	X		X	X			X	X	X
R.3	X	X	X	X			X			X	X	X
R.4	X		X	X		X				X	X	X
R.5	X		X	X	X					X	X	X
R.6		X	X	X			X			X	X	X
R.7	X		X	X				X		X	X	X

R.8	X		X	X				X		X	X	X
R.9	X	X	X	X		X	X			X	X	X
R.10	X		X	X	X					X	X	X
R.11		X	X	X			X			X	X	X
R.12	X		X	X				X		X	X	X
R.13	X		X	X				X		X	X	X
R.14	X		X	X		X		X		X	X	X
R.15	X	X										
R.16	X	X	X	X	X				X	X	X	X
R.17	X	X	X	X	X					X	X	X
R.18	X		X	X	X					X	X	X
R.19	X	X	X	X		X	X			X	X	X
R.20	X		X	X			X			X	X	X
R.21	X		X	X	X					X	X	X
R.22		X	X	X		X	X			X	X	X

G.1	Allows to regulate the influx of people that enter the building.
R.1	The system generates a single QR code to enter and exit the store for each booking or lining up.
R.2	The system allows to get a reservation for the supermarket.
R.6	The system allows people (who do not have access to the required technology) to digitally line up directly when they are at the store.
R.17	The system shows active reservations.
R.19	The system allows users to delete a reservation.
R.20	The system allows customers only one lining up at a time for each shop.
R.22	The system allows the store manager to scan the QR codes.
C.1	CustomerMobileApp

C.2	StoreManagerMobileApp
C.3	Routing
C.4	Middleware
C.5	UserController
C.6	BookingController
C.7	LineupController
C.8	ShopController
C.10	Query Builder
C.11	Model
C.12	DBMSService

G.2	Avoids that customers must line up and wait outside of stores for hours.
R.1	The system generates a single QR code to enter and exit the store for each booking or lining up.
R.2	The system allows to get a reservation for the supermarket.
R.3	The system provides customers a precise estimation of the waiting time.
R.5	The system alerts the customers before their shift according to the geolocation information.
R.6	The system allows people (who do not have access to the required technology) to digitally line up directly when they are at the store.
R.9	The system allows customers to insert the approximate expected duration of the visit.
R.10	The system infers customers' expected duration of the visit based on an analysis of the previous visits.
R.16	The system requires a sign up/login.
R.21	The system uses information about the customer that exit the store to infer better the waiting time.
R.22	The system allows the store manager to scan the QR codes.
C.1	CustomerMobileApp

C.2	StoreManagerMobileApp
C.3	Routing
C.4	Middleware
C.5	UserController
C.6	BookingController
C.7	LineupController
C.9	ManagerController
C.10	Query Builder
C.11	Model
C.12	DBMSService

G.3	Guarantees that everyone can shop, even people who do not have access to the required technology.
R.4	The system allows customers only one booking at a time for each shop.
R.6	The system allows people (who do not have access to the required technology) to digitally line up directly when they are at the store.
R.7	The system suggests alternative time slots for visiting the store when the desired one is not available.
R.8	The system suggests alternative stores when the desired one is not available.
R.14	The system shows the available time slots for each grocery.
R.15	The system provides a QR code printing service.
R.16	The system requires a sign up/login.
R.22	The system allows the store manager to scan the QR codes.
C.1	CustomerMobileApp
C.2	StoreManagerMobileApp
C.3	Routing
C.4	Middleware

C.5	UserController
C.6	BookingController
C.7	LineupController
C.8	ShopController
C.9	ManagerController
C.10	Query Builder
C.11	Model
C.12	DBMSService

G.4	Provides smart managing of lining up and booking with a digital system.
R.1	The system generates a single QR code to enter and exit the store for each booking or lining up.
R.2	The system allows to get a reservation for the supermarket.
R.6	The system allows people (who do not have access to the required technology) to digitally line up directly when they are at the store.
R.7	The system suggests alternative time slots for visiting the store when the desired one is not available.
R.8	The system suggests alternative stores when the desired one is not available.
R.9	The system allows customers to insert the approximate expected duration of the visit.
R.10	The system infers customers' expected duration of the visit based on an analysis of the previous visits.
R.11	The system allows store managers to get a lining up only for own store.
R.12	The system provides periodic notifications of available time slots in a day/time range.
R.13	The system shows the list of shops.
R.15	The system provides with a QR code printing service.
R.18	The system shows the history of reservation of each customer.
C.1	CustomerMobileApp

C.2	StoreManagerMobileApp
C.3	Routing
C.4	Middleware
C.5	UserController
C.6	BookingController
C.7	LineupController
C.8	ShopController
C.10	Query Builder
C.11	Mode
C.12	DBMSService

5 IMPLEMENTATION, INTEGRATION AND TEST PLAN

6 EFFORT SPENT

This section shows the amount of time that each member has spent to produce the document. Please notice that each section, diagram, and specification is the result of coordinated work. The column *Member* specifies only the main contributor (or contributors, if more than one) for each topic but should not be interpreted as a lack of participation by other team members for that topic.

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7 REFERENCES

- The diagrams have been made with: <https://www.visual-paradigm.com/> and <https://lucid.co/it>
 - The mockups have been made with: Adobe XD
 - Sequence Diagram Reference: <https://www.uml-diagrams.org/sequence-diagrams-reference.html>
 - *UML - Imparare a descrivere sistemi orientati agli oggetti graficamente e in modo standard*, APOGEO, Enrico Amedeo
-
- <https://www.ibm.com/cloud/learn/three-tier-architecture>
 - https://en.wikipedia.org/wiki/Multitier_architecture
 - <https://en.wikipedia.org/wiki/Model%E2%80%93view%E2%80%93controller>