POLITECNICO
MILANO 1863

CLup

Design Document

Simone Abelli
Stefano Azzone

Deliverable:	DD
Title:	Design Document
Authors:	Simone Abelli, Stefano Azzone
Version:	1.0
Date:	19 December 2020
Download page:	https://github.com/StefanoAzzone/AbelliAzzone
Copyright:	Copyright © 2020, Simone Abelli, Stefano Azzone – All rights reserved

Contents

1 Introduction

1.1 Purpose

The purpose of this document is to provide more technical and detailed information about the software discussed in the RASD document. The Design Document is a guide for the programmer that will develop the application in all its functions. The document will explain and motivate all the architectural choices by providing a description of the components and their interaction. We will also enforce the quality of the product through a set of design characteristics. Finally we describe the implementation, integration and test planning.
The topics touched by this document are:

- high level architecture
- main components, their interfaces and deployment
- runtime behavior
- design patterns
- more details on user interface
- mapping of the requirements on the components of the architecture
- implementation, integration and test planning

1.2 Scope

CLup is a system that allows customers to line up in a virtual first in first out queue, in order to avoid overcrowding outside of stores. Customers can queue up remotely or on premise (by using a device installed outside the store). When a customer queues up remotely he/she can choose to line up immediately or to book a future visit. The system alerts customers when it is time for them to depart to reach the store. The system builds statistics on customer entry and exit in order to provide a better estimation of waiting times. The system allows the store owners to control the occupation of each of their stores. This is just a summary of all the features of the system, for a more detailed description of the software functionalities read the RASD.

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

Reservation	Virtual or physical artifact used to identify the position of a customer in a queue
Queue up	Customers are lined up in a FIFO queue
Enqueued	A customer is enqueued when he has provided the system with a means of identification and requested a reservation
Authorized	A customer is authorized when he has been enqueued and is allowed temporary access to the store.
Occupation	Number of customers currently present in the store
Printer	Device that can read a social security card and print tickets that contains a progressive number and an estimate of the waiting time.

1.3.2 Acronyms

RASD	Requirement Analysis and Specification Document
GPS	Global Positioning System
S2B	Software to be
UI	User Interface
FIFO	First in first out

1.3.3 Abbreviations

Gn	Goal number n
Rn	Requirement number n
Dn	Domain Assumption number n
WPn	World Phenomenon number n
SPn	Shared Phenomenon number n

1.4 Revision history

Not yet defined.

1.5 Reference Documents

1. IEEE Std 830-1998 Recommended Practice for Software Requirements Specifications
2. Specification Document: R&DD Assignment A.Y. 2020/2021
3. uml-diagrams.org

1.6 Document Structure

- Chapter 1: gives an introduction about the project, describing the purpose of the system informally and defining its scope, its main goals, world and shared phenomena. Moreover this section contains specifications such as the definitions, acronyms, abbreviation, revision history of the document and the references.
- Chapter 2: contains the overall description of the project, with a more in-depth look at its functionalities. Here are identified the main actors involved in the application's usage lifecycle, some scenarios useful to identify specific cases in which the application can be utilized, and all the necessary domain assumptions, dependencies and constraints. This section also provides a class diagram, which aid to better understand the general structure of the project, and some state diagrams, to make the evolution of the crucial objects clear.
- Chapter 3: This section contains the core of the document: first it presents the interface requirement including user, hardware, software and communication interfaces. Then it offers the specification and the description of all the functional requirements necessary in order to reach the goals; is also provided a list of use cases, with their corresponding sequence diagrams and their mapping on the requirements. Finally non-functional requirements are defined, including performance, design and the software systems attributes.
- Chapter 4: includes the alloy code and the corresponding metamodels generated from it, in order to show how the project has been modeled and represented through the language.
- Chapter 5: shows the effort which each member of the group spent working on the project.
- Chapter 6: includes the reference documents.

2 Architectural Design

3 User Interface Design

4 Requirements Traceability

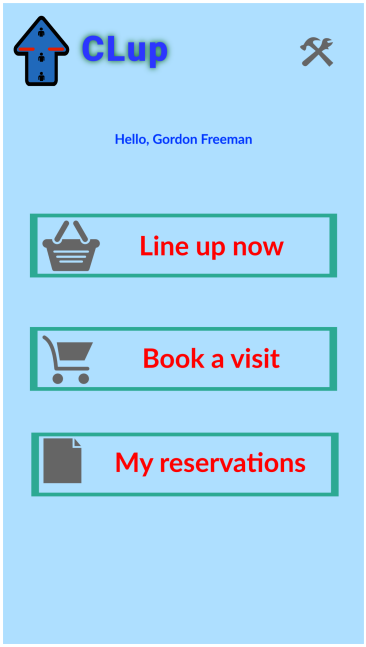
4.1 External interface requirements

4.1.1 User interfaces

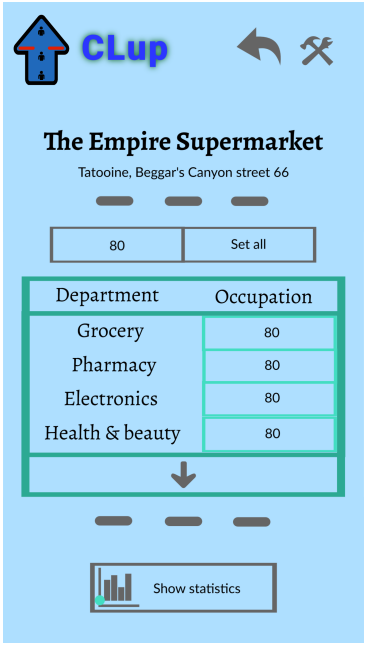
There are two categories of users that have different interface requirements:

- **Customers**
  Customers belong to all demographics so a user friendly interface is needed. The customer is presented with a main menu which allows him/her to:
  - line up immediately (immediate reservation) at a specific store
  - book a visit (future reservation) at a specific store
  - view and delete existing reservations

  The customer will receive a notification when it is time for him/her to depart to reach the shop.



- **Store owners**
  The store owner is presented with a main menu from which he/she can:
  - register a store to the system
  - delete a store from the system
  - view and edit occupation for currently registered stores



4.1.2 Hardware interfaces

The S2B requires the following hardware interfaces:

1. **Computer or smartphone**
   Users will need a computer or a smartphone to access the system's services which are provided via an application (only for smartphone owners) and a web application. Only users with an application will be able to receive notifications that alert them when it is time for them to depart and reach the store.

2. **Turnstiles**
   Turnstiles allow authorized customers to enter or exit the store by providing a means of identification. (i.e. QR, NFC)

3. **Ticket printer**
   The ticket printers located outside stores allows potential customers to queue up on premise provided that they identify themselves (e.g. social security card).

4. **Monitor**
   A monitor located outside stores allows customers that queue up on premise to know when it is time for them to access the store.

4.1.3 Software interfaces

The system uses a public API to locate the customer and provide him/her with notifications about the time he will need to depart to reach the store.

4.1.4 Communication interfaces

Customers can access the system through a working internet connection.

4.2 Functional requirements

4.2.1 List of requirements

R1 Turnstiles unlock if and only if activated by authorized customers.

R2 The number of customers in each department of the store never exceeds the occupation set by the owner.

R3 The monitor outside the store displays the number of the last authorized customer.

R4 The system allows customers and store owners to register and log in.

R5 The system validates the authenticity of the identifying information provided.

R6 The system allows customers to search for a store among those registered by their owners.

R7 Registered customers can send a reservation request to the system.

R8 Non registered customers with an identifying document can request reservations through the printer.

R9 Registered customers that book a visit can specify estimated visit duration.

R10 Registered customers that book a visit can specify desired product categories.

R11 The system provides customers with a QR code to enter the store once authorized.

R12 The system uses gathered data to build statistics.

R13 Registered customers with a smartphone are alerted when their turn is near.

R14 Registered customers can delete a pending or authorized reservation.

R15 Authorized reservations expire if they do not become current in a certain time window (specified by store owner)

R16 Registered customers must specify desired means of transport while requesting a reservation.

R17 Reservations are authorized according to a FIFO policy

4.2.2 Mapping on requirements

G1	D1, D2, D5, D6, D8, D9	R1, R2, R4, R5, R6, R7, R11, R16, R17
G2	D1, D2, D3, D4, D5, D6	R1, R2, R3, R5, R8, R11, R17
G3	D1, D2, D3, D4, D5, D6, D8, D9	R1, R2, R3, R4, R5, R6, R7, R9, R10, R11, R16, R17
G4	D1, D2, D5, D8, D9	R1, R2
G5	D8, D9	R9, R12, R14, R15
G6	D4, D7, D8, D9	R3, R13

Here we remind the goals for ease of use:

G1 CLup should allow customers to queue up remotely

G2 CLup should allow customers to queue up on premise

G3 CLup should allow customers to book future visits to stores

G4 CLup should allow store owners to regulate the maximum number of customers in their stores

G5 CLup should provide the customer with a reasonably precise estimate of waiting time

G6 CLup should alert the customers when it is time to get to the shop taking into account travel time

Here we remind the domain assumptions for ease of use:

D1 The stores have QR activated turnstiles.

D2 Turnstiles let one and only one person in each time they unlock.

D3 Outside stores is a social security card activated ticket printer.

D4 Outside stores there is a monitor.

D5 There is no way for a customer to enter a store except from entrance and exit.

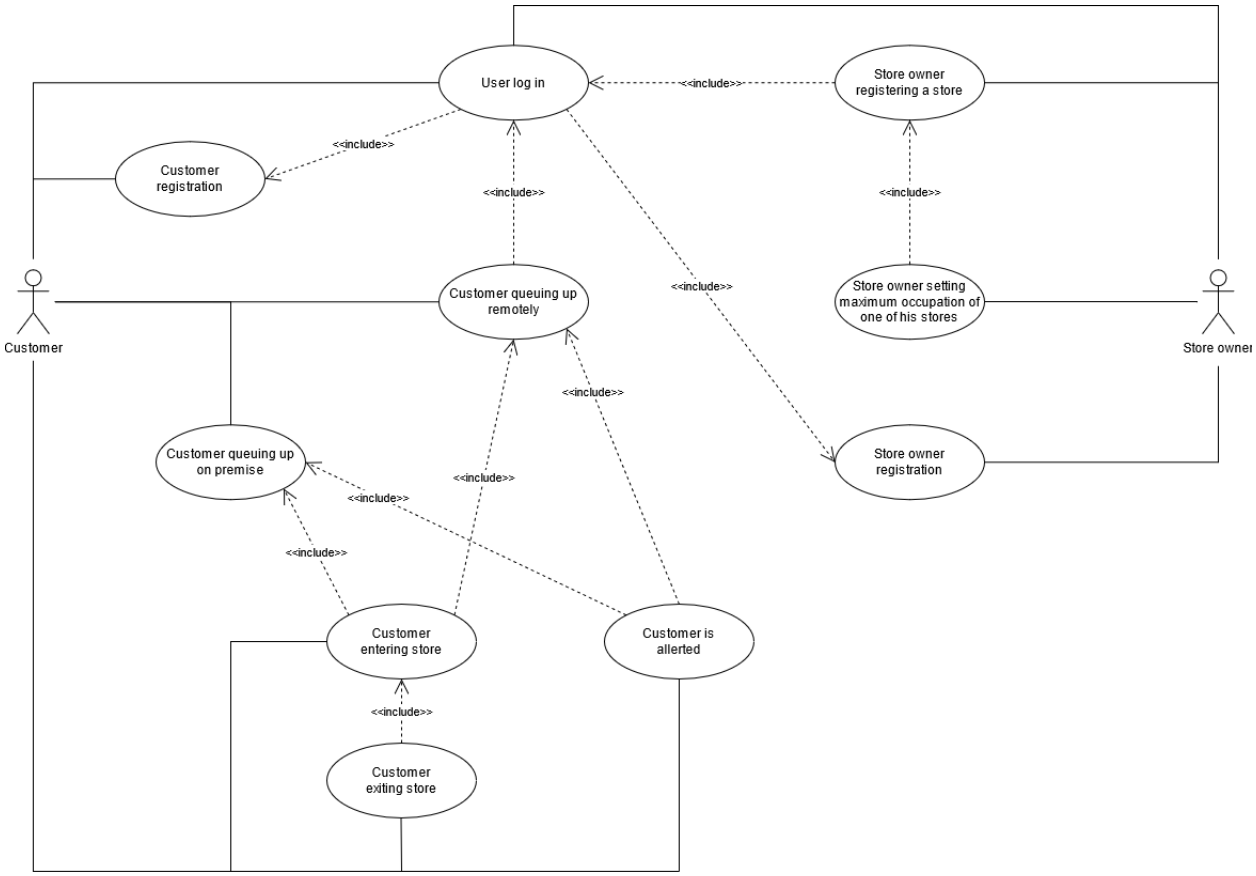
D6 Each customer has either a telephone number or an identification document.

D7 When provided, user location has maximum error of 5 meters.

D8 To register to the S2B users must have either a smartphone or a computer.

D9 To register and use the S2B users must have an internet connection.

4.2.3 Use case diagram



4.2.4 Use cases

4.2.4.1 Customer registration

Name	Customer registration
Actors	Customer
Entry condition	Customer has opened the smartphone application or the web app on his computer but has not logged in
Event flow	1. a registration menu is provided to the customer 2. from such menu the customer selects the option to sign up as customer 3. the customer is then prompted to insert identifying information 4. the customer inserts requested information 5. the system validates provided information 6. the system confirms the registration of the customer and saves information provided
Exit conditions	Customer has registered to the system
Exceptions	1. a customer with same identifying information already exists 2. validation of identifying information is not successful 3. the customer decides to cancel the registration If one of the first two events described above occur, the application will alert the customer and provide him with the possibility to retry or go back to the initial menu. If event 3 occurs the customer is redirected to the main page.

4.2.4.2 Store owner registration

Name	Store owner registration
Actors	Store owner
Entry condition	Store owner has opened the smartphone application or the web app on his computer but has not logged in
Event flow	1. a registration menu is provided to the store owner 2. from such menu the store owner selects the option to sign up as store owner 3. the store owner is then prompted to insert identifying information 4. the store owner inserts requested information 5. the system validates provided information 6. the system confirms the registration of the store owner and saves information provided
Exit conditions	Store owner has registered to the system
Exceptions	1. a store owner with same identifying information already exists 2. validation of identifying information is not successful 3. the store owner decides to cancel the registration If one of the first two events described above occur, the application will alert the store owner and provide him with the possibility to retry or go back to the initial menu. If event 3 occurs the store owner is redirected to the main page.

4.2.4.3 User logs in

Name	User logs in
Actors	Customer or store owner
Entry condition	The user has opened the application on his device, and has already registered to the system
Event flow	1. User chooses to log in from the welcome menu 2. User identifies him/herself with created credentials
Exit conditions	User is logged in
Exceptions	1. User credentials are invalid If the event described above occurs, the application will alert the user and allows him to retry

4.2.4.4 Customer queuing up remotely

Name	Customer queuing up remotely
Actors	Customer
Entry condition	Customer has logged in on the smartphone application or the web app on his computer
Event flow	1. customer selects to queue up from main menu • with an immediate reservation • with a future reservation (and optionally inserts desired categories of item he/she intends to buy and how much time he/she intends to spend at the store) 2. customer selects a store from the list of stores registered to the system 3. customer specify whether he is going to reach the store by car or on foot 4. customer submits reservation request
Exit conditions	Customer reservation is confirmed
Exceptions	1. customer decides to cancel the reservation 2. customer requests immediate reservaiton but store is closed at that time If one of the events described above occur, the application will alert the customer and go back to the initial menu

4.2.4.5 Customer queuing up on premise

Name	Customer queuing on premise
Actors	Customer
Entry condition	Customer has reached the store ticket printer
Event flow	1. customer selects the option to queue up from main menu of the ticket printer 2. customer provides the ticket printer with a means of identification (e.g. social security card)
Exit conditions	Customer reservation is confirmed and a ticket is printed containing the following information: • how much time he needs to wait before being able to enter the store • a progressive number that will allow him to know when his/her turn is
Exceptions	1. customer decides to cancel the reservation If one of the events described above occur, the application will alert the customer and go back to the initial menu

4.2.4.6 Customer entering store

Name	Customer entering store
Actors	Customer
Entry condition	Customer has logged in on the smartphone application and is at the entrance of a store or has printed authorization from the web app
Event flow	If the customer has not printed the reservation ticket he must use his smartphone: 1. customer selects the option to show existing reservations from main menu of the phone app 2. customer selects an existing reservation and if authorized (i.e. it is his turn to enter the store) he/she is given the means to identify him/herself (e.g. display QR or activate NFC) Then the customer identifies him/herself at the turnstiles
Exit conditions	Customer enters the store
Exceptions	1. customer is not authorized to enter the store If the event described above occurs, the turnstiles will not let the customer in

4.2.4.7 Customer exiting store

Name	Customer exiting store
Actors	Customer
Entry condition	Customer has logged in on the smartphone application and is in a store
Event flow	If the customer has not printed the reservation ticket he must use his smartphone: 1. customer selects the option to show existing reservations from main menu 2. customer selects an existing reservation and if authorized (i.e. it is his turn to enter the store) he/she is given the means to identify him/herself (e.g. display QR or activate NFC) Customer identifies him/herself at the turnstiles
Exit conditions	Customer exits the store
Exceptions	

4.2.4.8 Store owner registering a store

Name	Store owner registering a store
Actors	Store owner
Entry condition	Store owner has logged in on the smartphone application or the web app on his computer
Event flow	1. store owner selects the option register a store from main menu 2. store owner inserts necessary information and sets up equipment (i.e. connect printer, monitor and turnstiles to the system) 3. store owner submits store registration request
Exit conditions	Store registration is confirmed
Exceptions	1. information is missing or incorrect 2. equipment is not working properly 3. store owner decides to cancel the store registration If one of the events described above occur, the application will alert the store owner and provide him with the possibility to retry or go back to the initial menu

4.2.4.9 Store owner setting maximum occupation of a store or a department

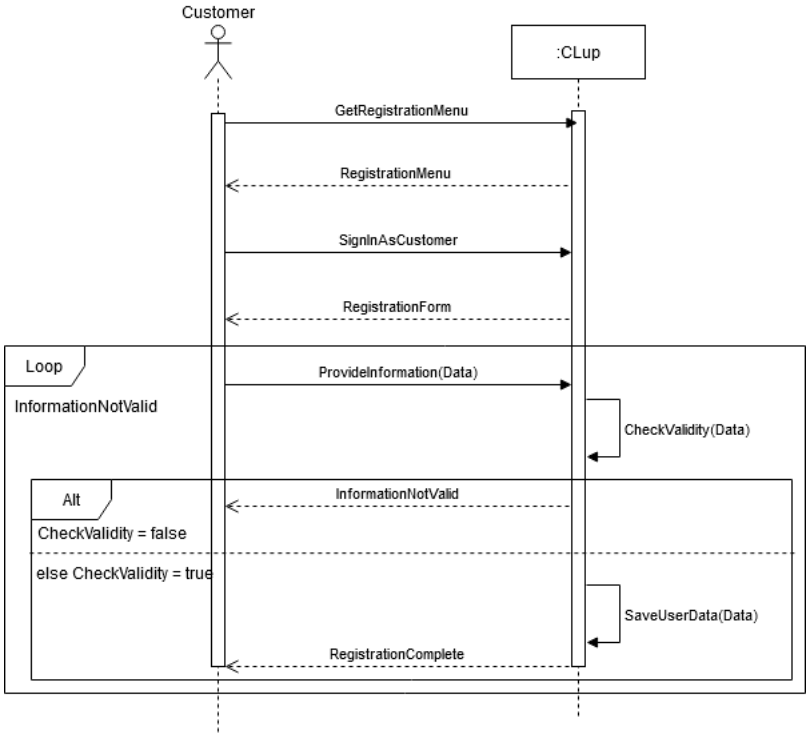
Name	Store owner setting maximum occupation of a store or a department
Actors	Store owner
Entry condition	Store owner has logged in on the smartphone application or the web app on his computer
Event flow	1. store owner selects one of his stores from the list reachable form the main menu 2. store owner views current occupation of each department of his store, and current occupation threshold 3. sets the new desired occupation threshold for a department or for the whole store
Exit conditions	The new occupation threshold is set
Exceptions	1. the threshold value is inadequate If the event described above occurs, the application will alert the store owner and provide him with the possibility to retry or go back to the initial menu

4.2.4.10 Customer is alerted

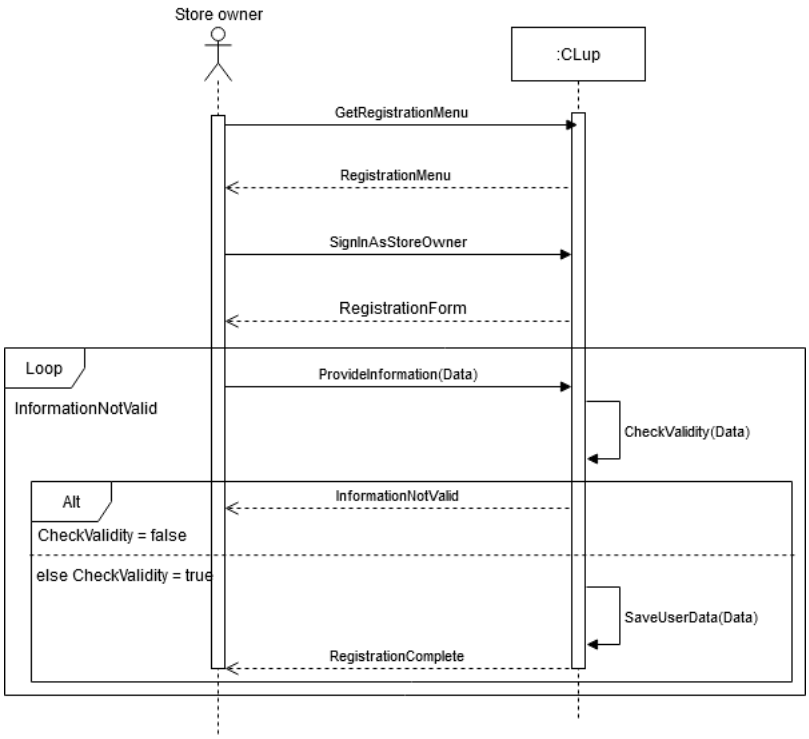
Name	Customer is alerted
Actors	Customer
Entry condition	Customer is logged into his smartphone application and the time he/she needs to wait becomes less or equal to the time he/she needs to reach the store
Event flow	1. The system sends a notification to the smartphone of the customer
Exit conditions	Customer is notified
Exceptions	1. the threshold value is inadequate If the event described above occurs, the application will alert the store owner and provide him with the possibility to retry or go back to the initial menu

4.2.5 Sequence diagrams

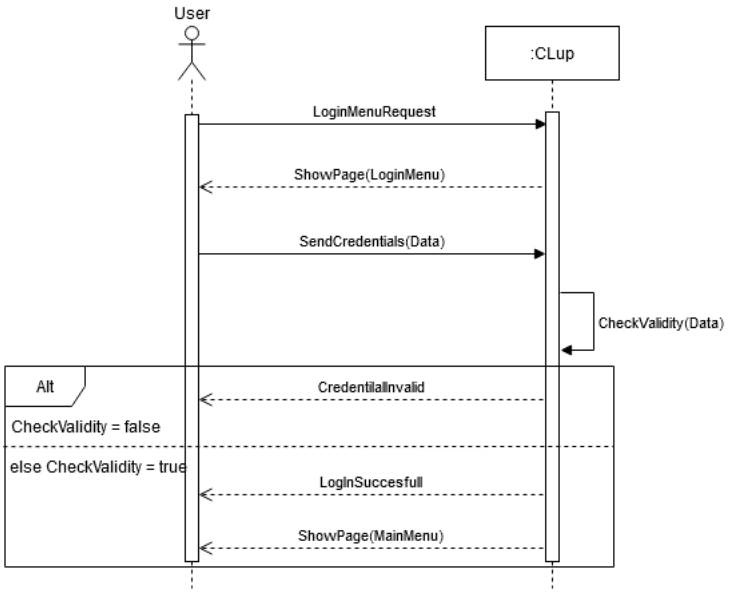
4.2.5.1 Customer registration



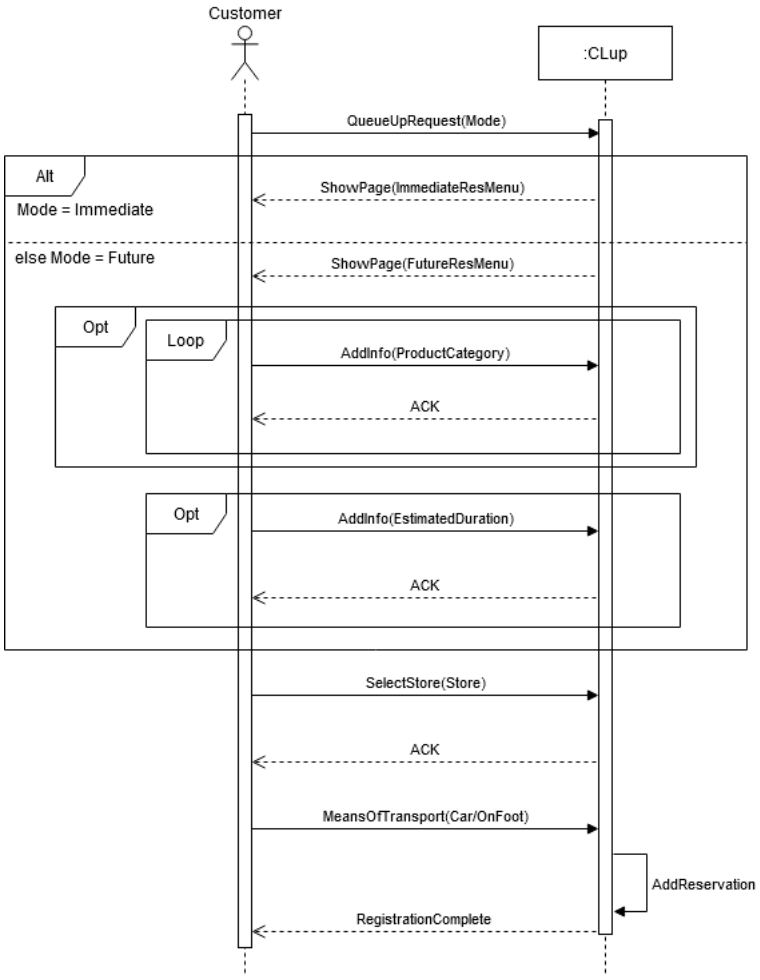
4.2.5.2 Store owner registration



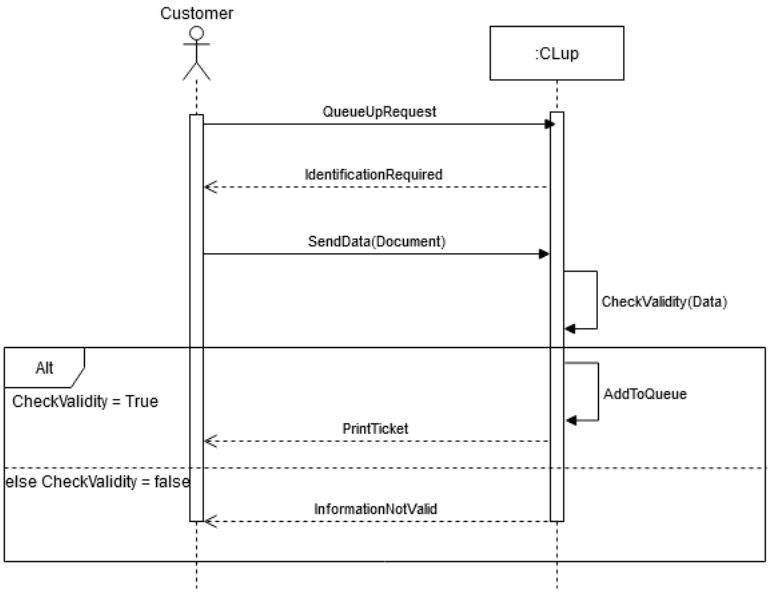
4.2.5.3 User logs in



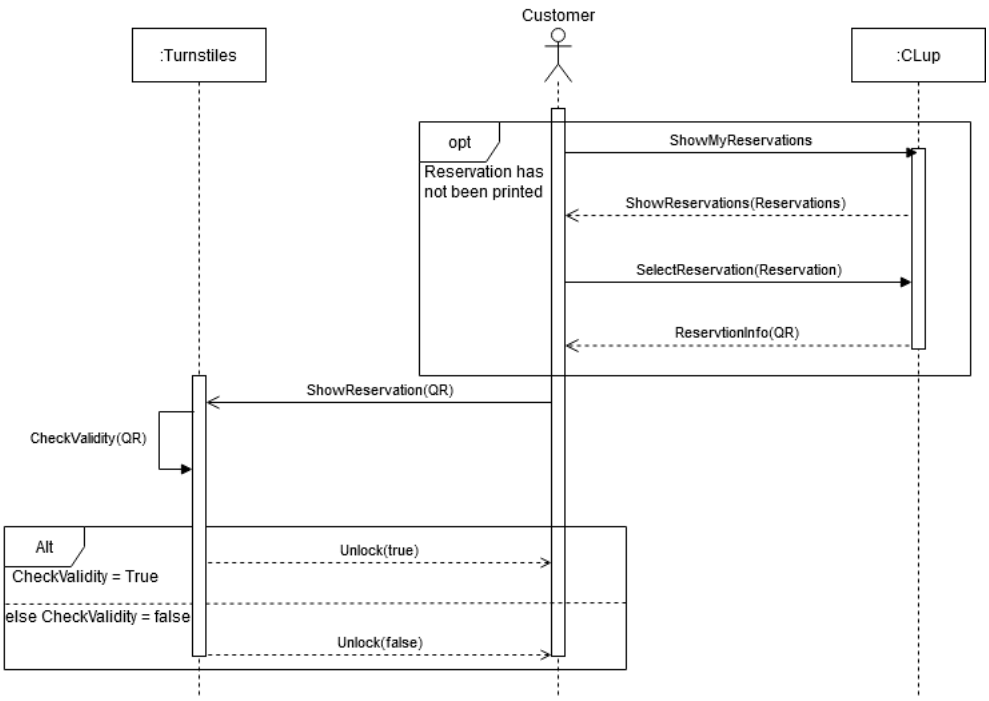
4.2.5.4 Customer queuing up remotely



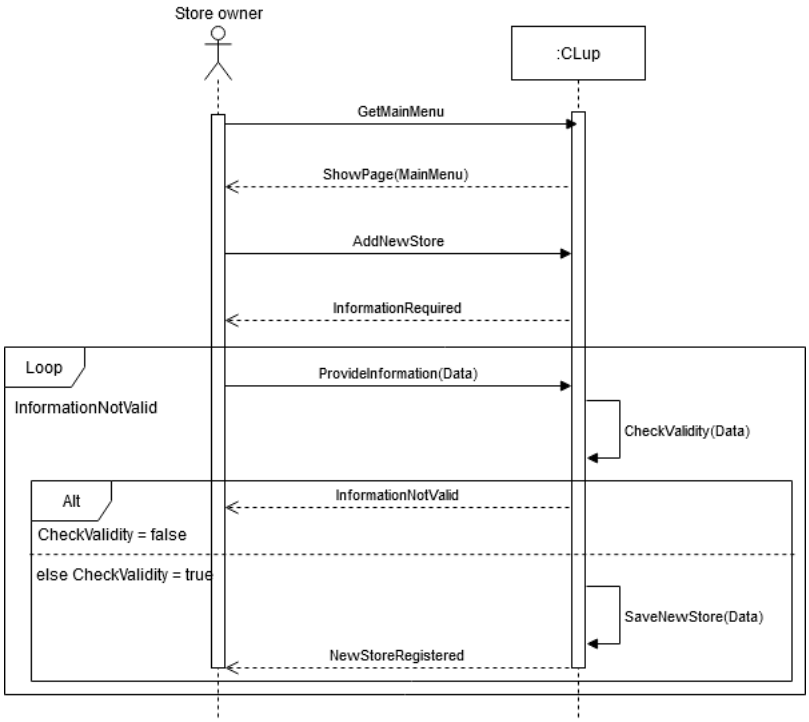
4.2.5.5 Customer queuing up on premise



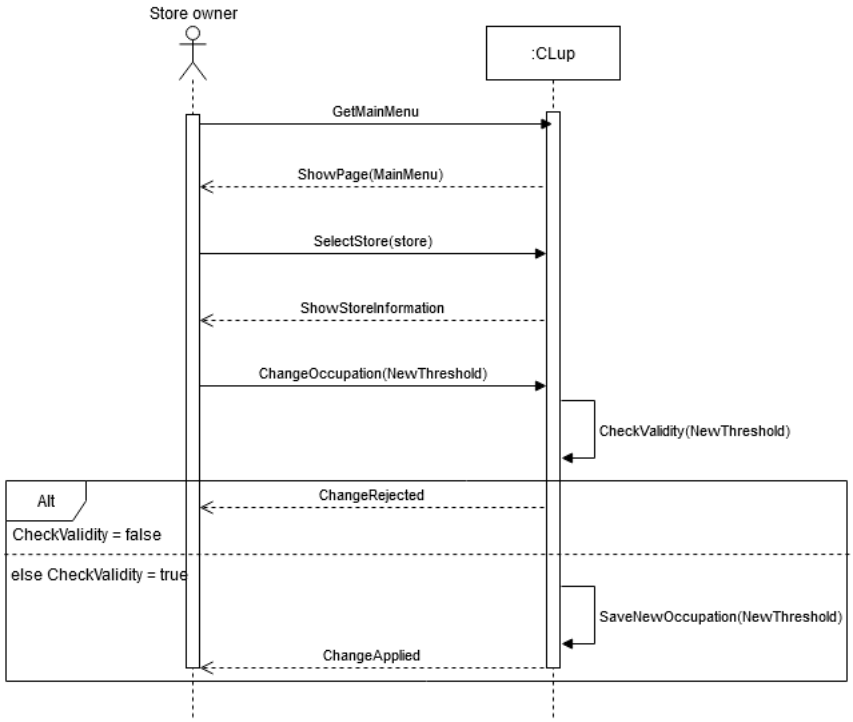
4.2.5.6 Customer entering and exiting store



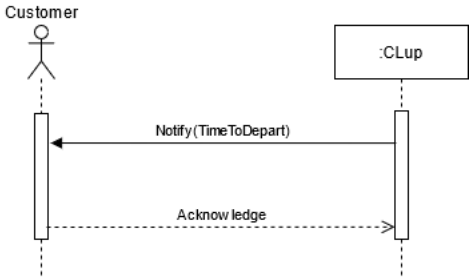
4.2.5.7 Store owner registering a store



4.2.5.8 Store owner setting maximum occupation of a store or a department



4.2.5.9 Customer is alerted



4.3 Performance Requirements

The system cannot guarantee that a customer can enter a store at a precise time unless it requires users to exit after a maximum time (which it doesn't). The system guarantees that if

- the customer uses a smartphone
- the customer never disconnects from the internet and GPS
- the customer specified the correct means of transport when creating the reservation

he/she will be alerted when he needs to depart to reach a store (in order not to be late) with a delay of at most 10 seconds.

4.4 Design Constraints

4.4.1 Standards compliance

The code should follow the requirements contained in this document, and be thoroughly commented.

4.4.2 Hardware limitations

The software the customer uses requires either:

- a smartphone to use the smart application
- a computer to use the web application and a home printer to print reservation

The software the store owner uses requires:

- turnstiles activated by QR
- reservation printer activated by social security card
- monitor to alert on premise customers when it is their turn

4.4.3 Any other constraint

Customers cannot have more than five active reservation requests for different stores and more than two for the same store on the same day to avoid fake reservations.

4.5 Software System Attributes

4.5.1 Reliability

The system must have an appropriate infrastructure with a full backup system located in an separate office distant at least 100km (nuclear fallout radius). Adequate personnel will guarantee recovery time to substitute faulty hardware.

4.5.2 Availability

The system should be up for 99.9% of the time (0.365 MTTR). Its temporary downtime does not cause emergency situations, but the system is an essential service: it should be possible to buy food every day. The system is fully automated. The users are alerted about system downtime with a delay of at most 10 minutes. The users are alerted that the system is up again with a delay of at most 10 minutes.

4.5.3 Security

The location of customers is sensitive information and therefore is never stored. Customers and store owners provide identifying information during registration: the databases containing such information must be protected against internal and external attacks. Communication between central system and users is encrypted.

4.5.4 Maintainability

The system is easy to maintain: its code is thoroughly commented and modular. Appropriate design patterns are exploited.

4.5.5 Portability

The smartphone application runs under Android and iOS. The web application runs under Android, iOS, Windows, MacOS.

5 Implementation, Integration and Test Plan

6 Effort Spent

Provide here information about how much effort each group member spent in working at this document. We would appreciate details here.

6.1 Simone Abelli

Introduction	3.5
UML class diagram	4
Product perspective	3
State charts, External interface requirements	4.5
User interfaces	4.5
Requirements	6.5
Sequence diagrams	3.5
Scenarios	0.5
Alloy	7

6.2 Stefano Azzone

Introduction	3
UML class diagram	3
Product perspective	3
Product functions, user characteristics, domain assumptions	2.5
State charts, External interface requirements	3
Use cases	3.5
Alloy	11.5
Requirements	6.5
Performance Requirements, Design constraints, Software system attributes, first two scenarios	1

References

- **drawio.org** was used to draw diagrams
- **alloy.mit.edu** was the reference for alloy model
- **uml-diagrams.org** was the reference for uml diagrams

