HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY
School of Information and communications technology

Software Design Document

Version 1.0

EcoBikeRental

Subject: IT Software Development

Group 10

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Table of Contents

List of Figures

No table of figures entries found.

List of Tables

No table of figures entries found.

1 Introduction

1.1 Objective

The objective of the document is to describe the requirements for EcoBikeRental Software. The goal is to have the EcoBikeRental Software requirements specification which is usable for the EcoBikeRental Software Design.

The document describes the potential users, domains and user-studies for EcoBikeRental Software. The document contains also EcoBikeRental Software conceptual model (as UML class diagrams), functional requirements (as UML use-case model and usage scenarios), and non-functional requirements in the level of details required for the first sprints. Thus, the requirements specification covers full-functionality in the low details, and the usage scenarios for the first sprints have been described in detail.

1.2 Scope

This software system will be a Eco Park Bike Rental System for everyone including novice users to use without any training. This system will be designed to allow for approximately 100 average concurrent users with no perceivable performance difference and can be operated upto 200 hours continuously. The system is also very responsive with typical response time around 1 second and only requires 2 hours of downtime for maintenance.

1.3 Glossary

Term	Definition
User	Main actor of the system
Map	The entire area of Eco Park, with detailed location of all docking stations
Docking station	The area to store all bikes available to the user
E-bike	Standard bike with an integrated electric motor for assisted propulsion
Twin bike	Standard bike with 2 saddles, 2 pedal and no electric motor

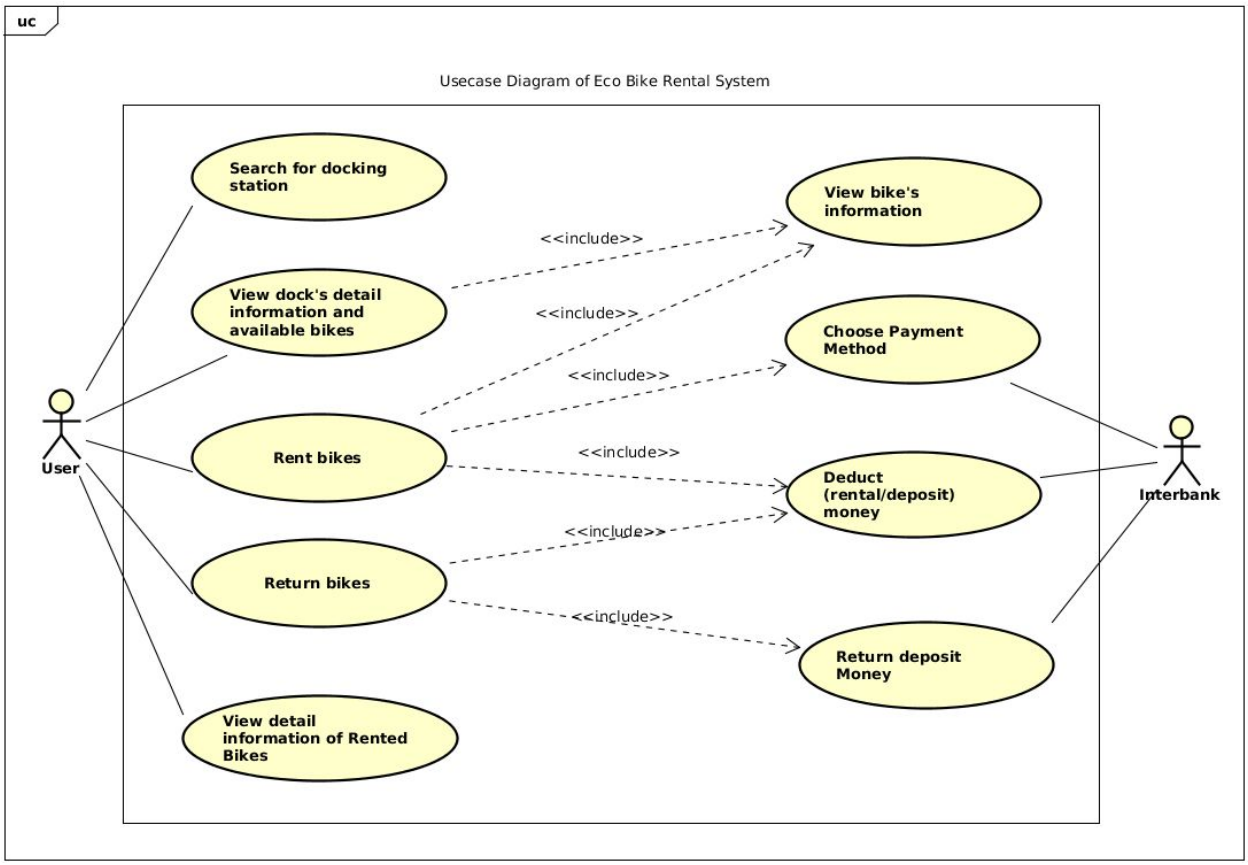
1.4 References

- IEEE. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design—Software Design Descriptions. IEEE Computer Society, 2009

2 Overall Description

2.1 General Overview

EcoBikeRental Software allows for interaction between 2 main actors: the Customer and the Interbank, across a variety of use cases



2.2 Assumptions/Constraints/Risks

2.2.1 Assumptions

The software assumes each client device to be equipped with a GPS-capable mobile device, connected to the internet for the duration of rental service, legibility with at least one supported interbank for the payment process.

2.2.2 Constraints

- For the time being, each user must have their own client installed and configured with their own payment card
- The software must be online at all times to ensure all bike and dock station status
- Users must agree to the terms and conditions about location privacy concerns

2.2.3 Risks

The software currently has no protection against attacks via direct contact with the client software due to no implemented features surrounding account based authentication

3 System Architecture and Architecture Design

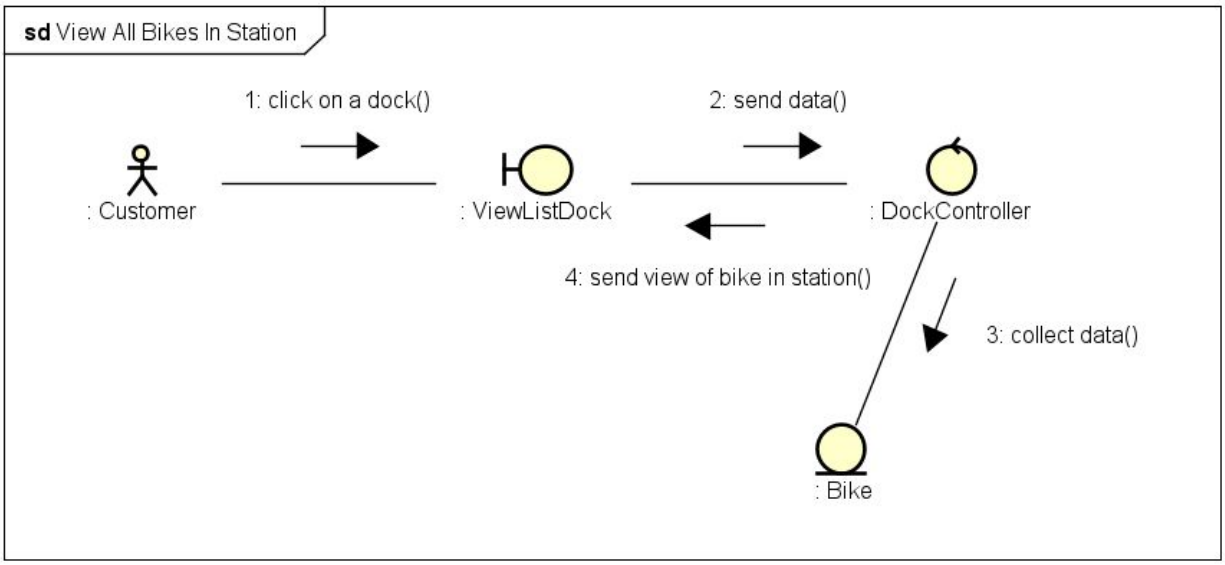
3.1 Architectural Patterns

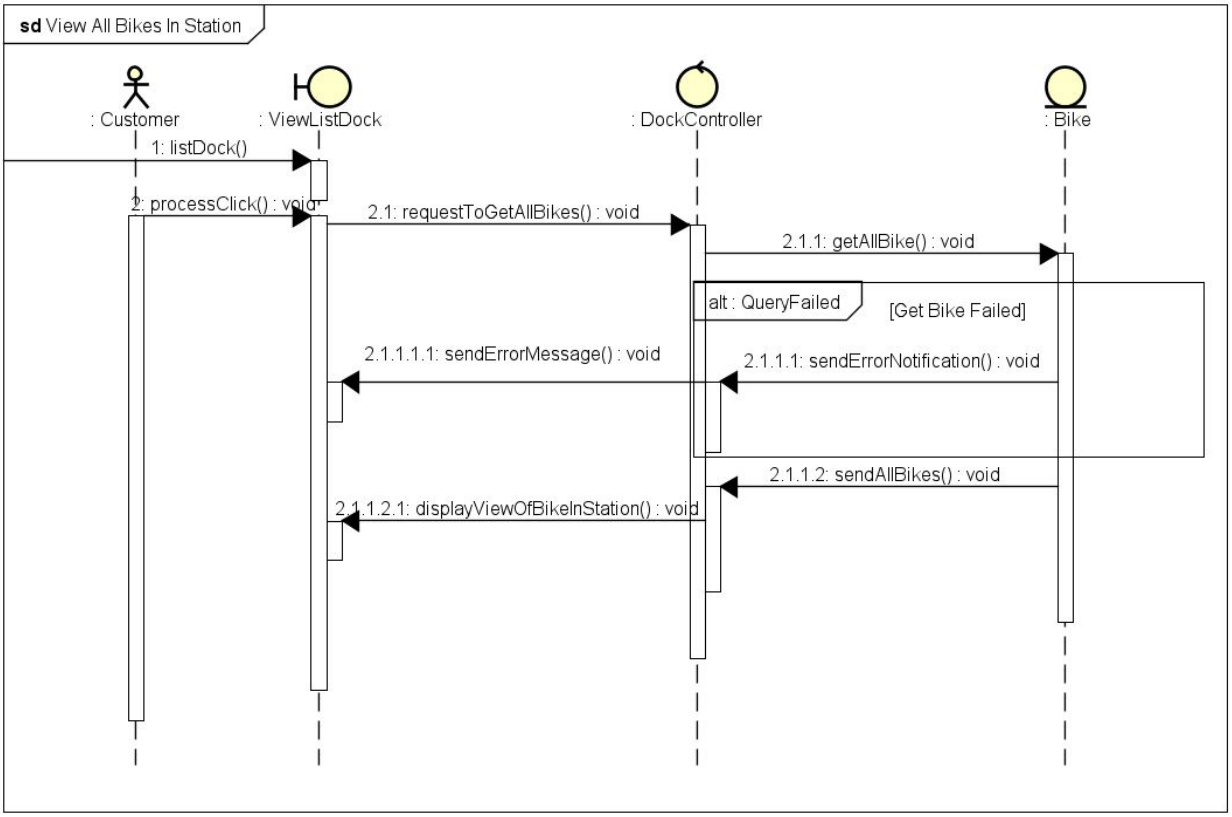
This architectural pattern is created following the MVC-model in order to build a system for renting bikes in our Ecopark residential. Each part of the architectural pattern normally contains a controller to process all the business requirements inside.

We choose this kind of architectural patterns because it's simple, light, and can be scalable for this project and also MVC is a very well-known design pattern that developers normally use for this kind of project

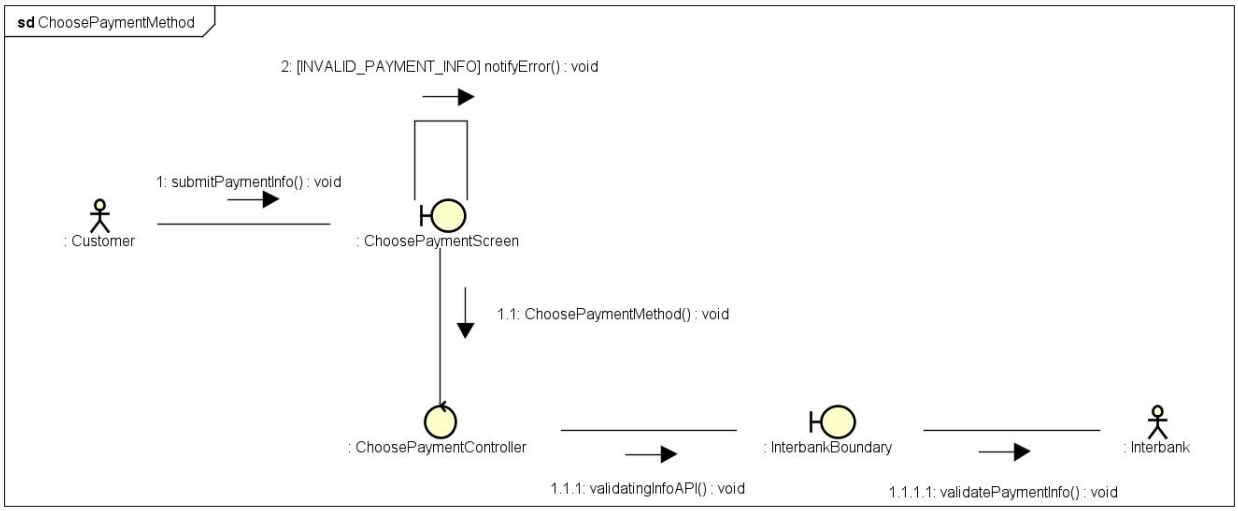
3.2 Interaction Diagrams

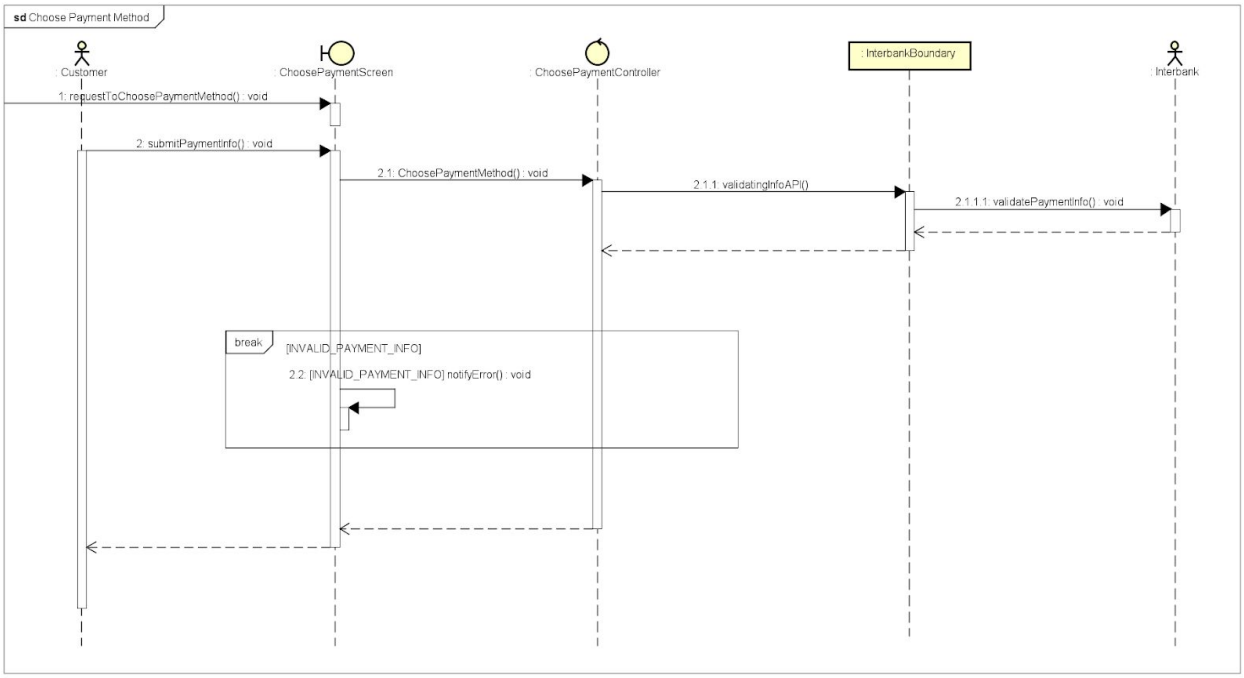
View All Bikes In Station sequence diagram + communication diagram



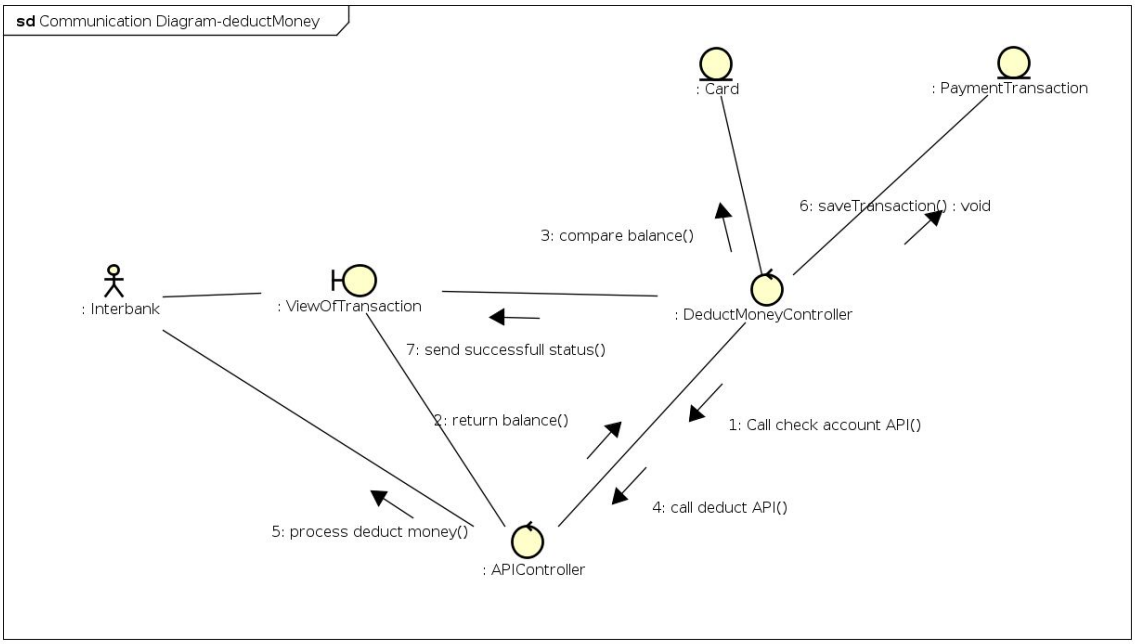


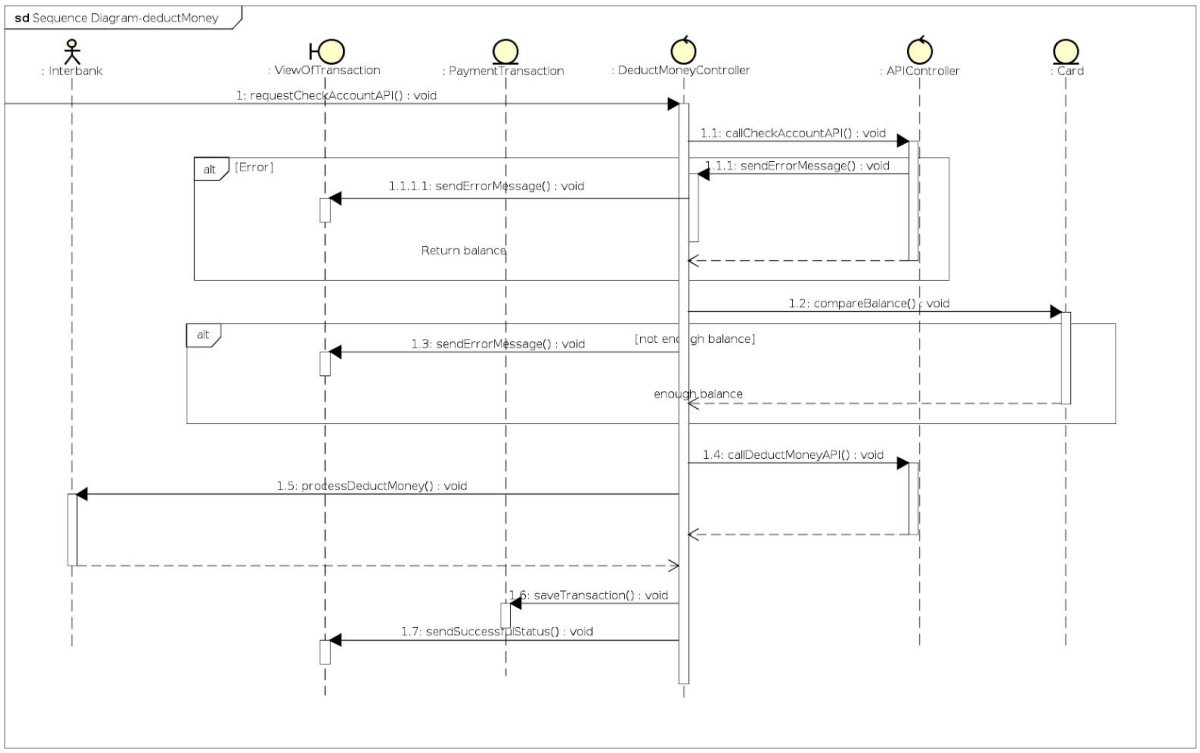
choosePaymentMethod sequence diagram + communication diagram



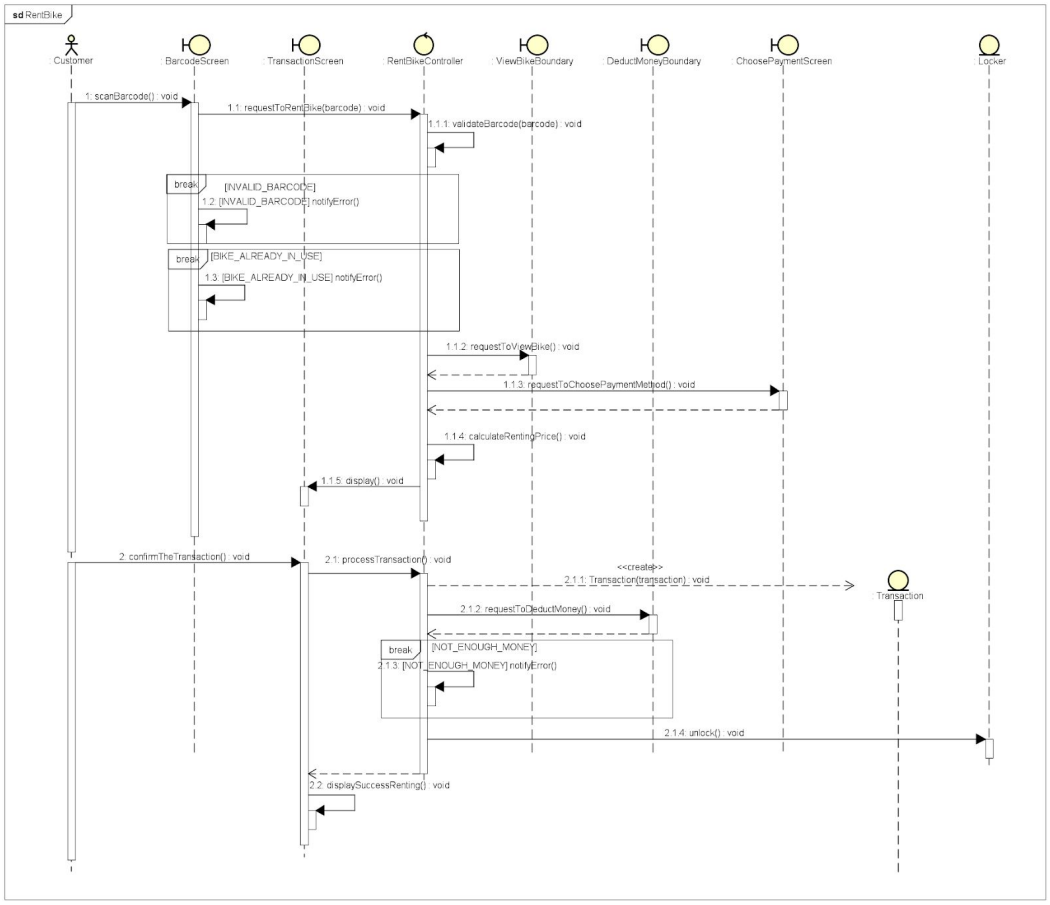


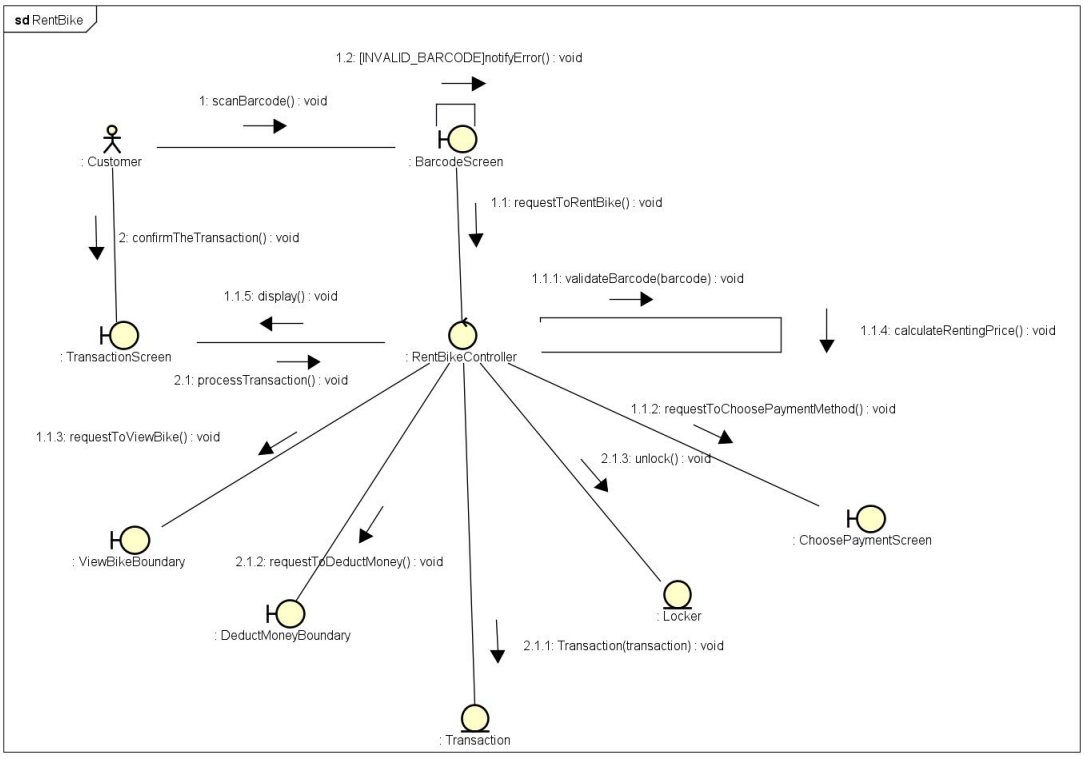
deductMoney sequence diagram + communication diagram



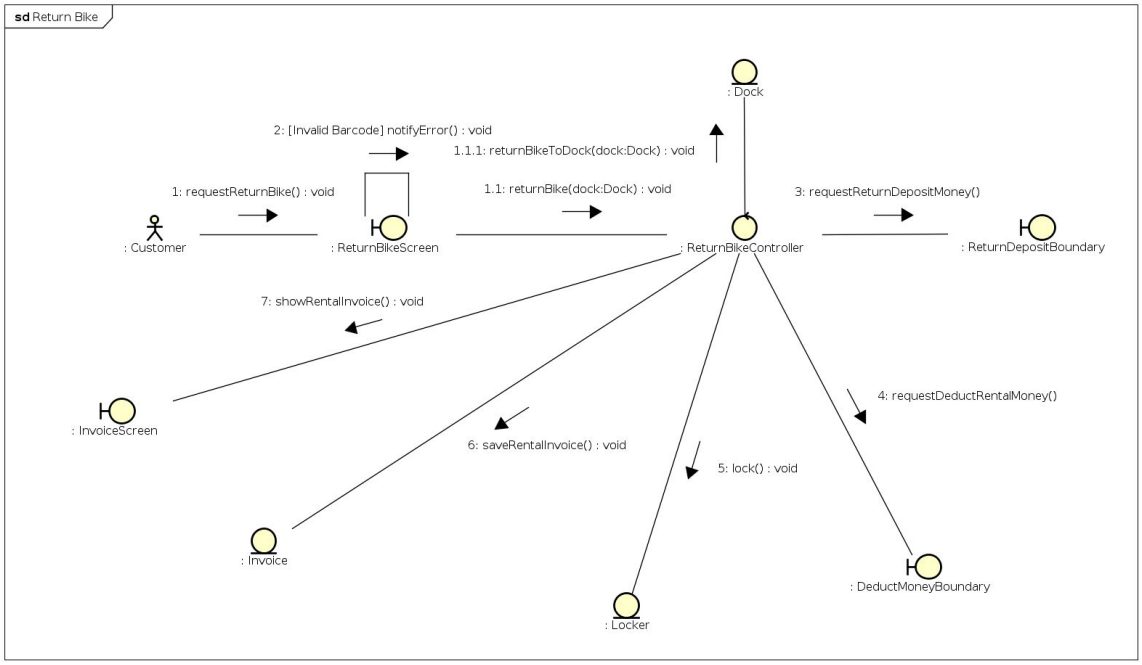


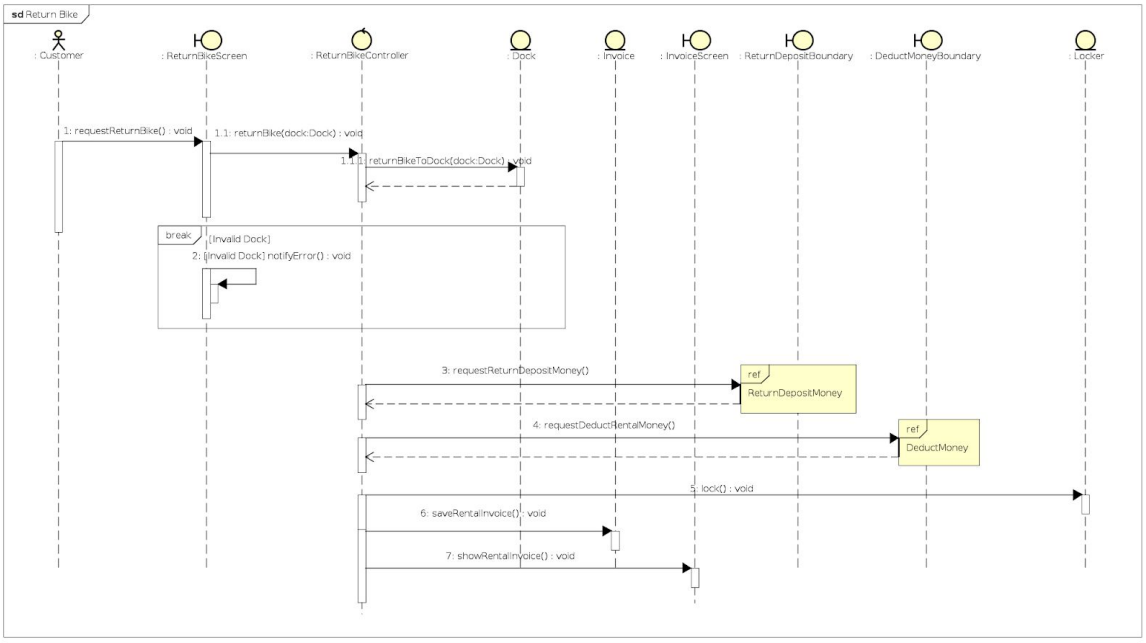
Renting Bikes sequence diagram + communication diagram



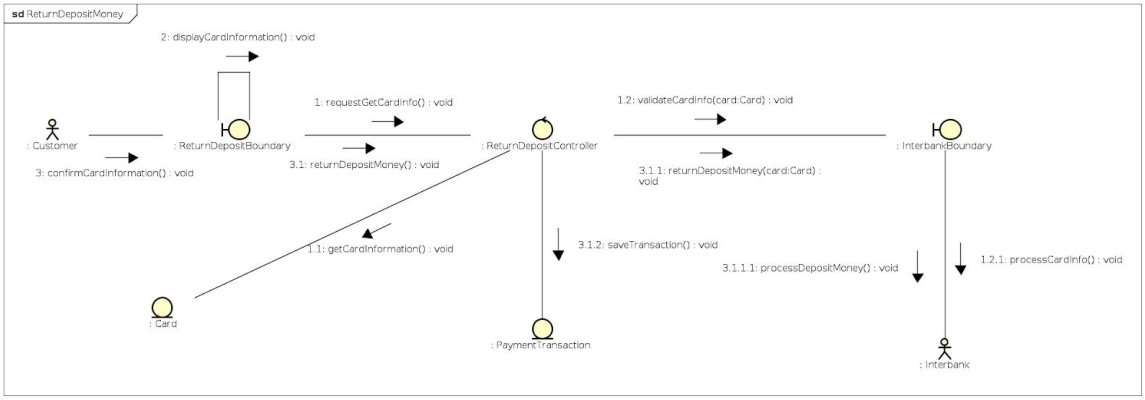


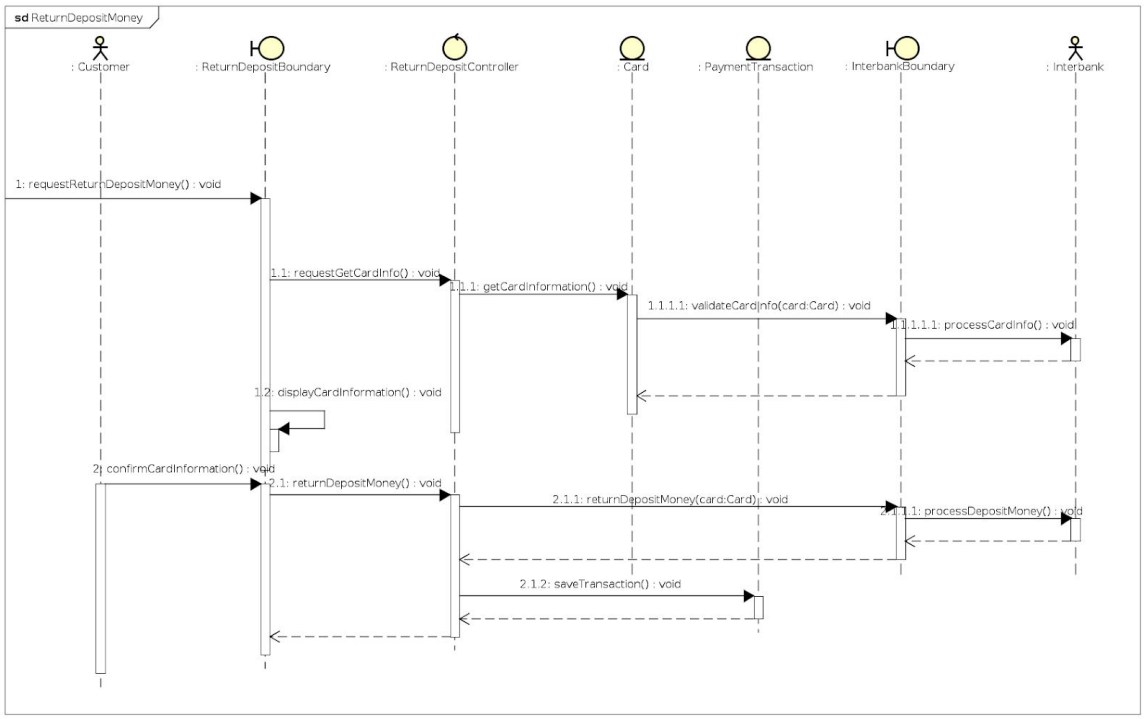
Return Bikes sequence diagram + communication diagram



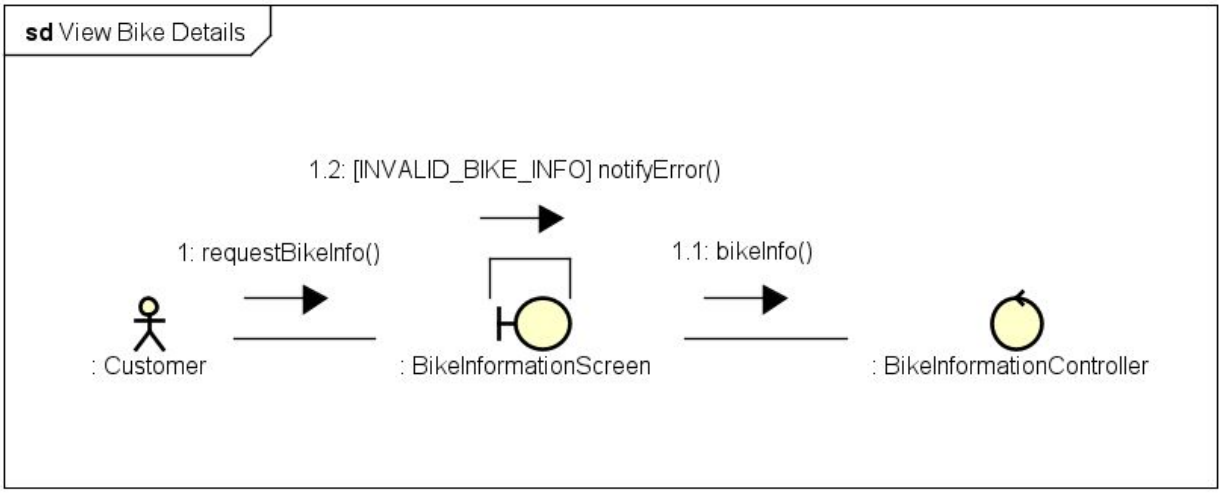


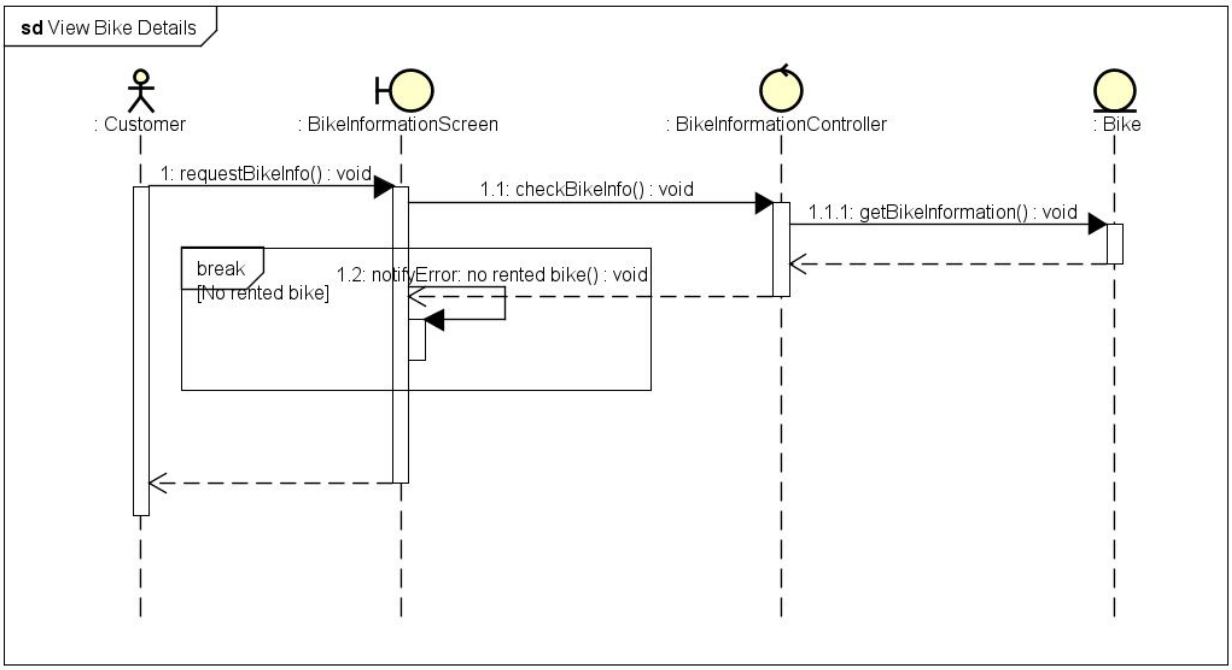
Return Deposit Money sequence diagram + communication diagram



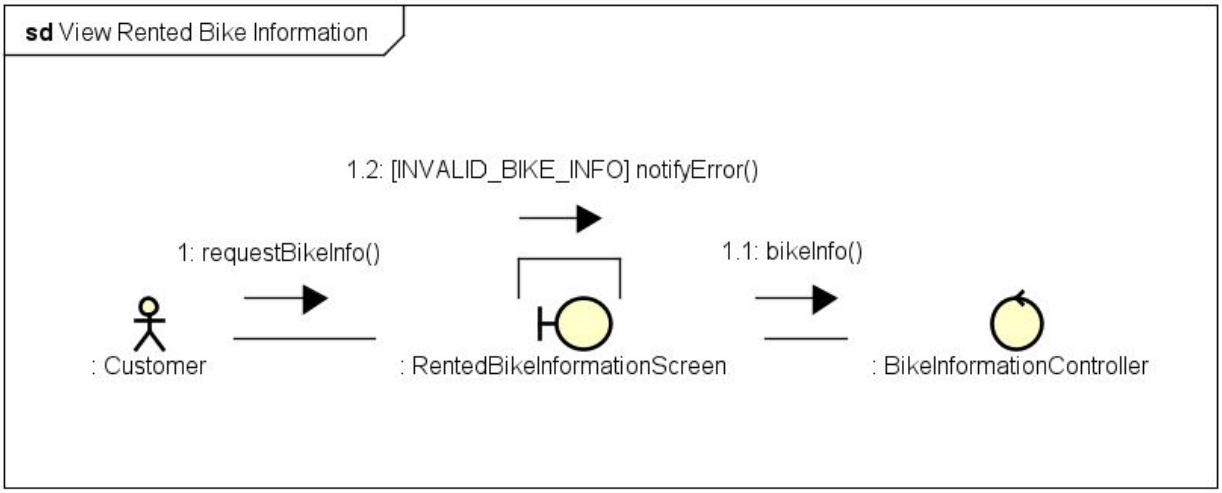


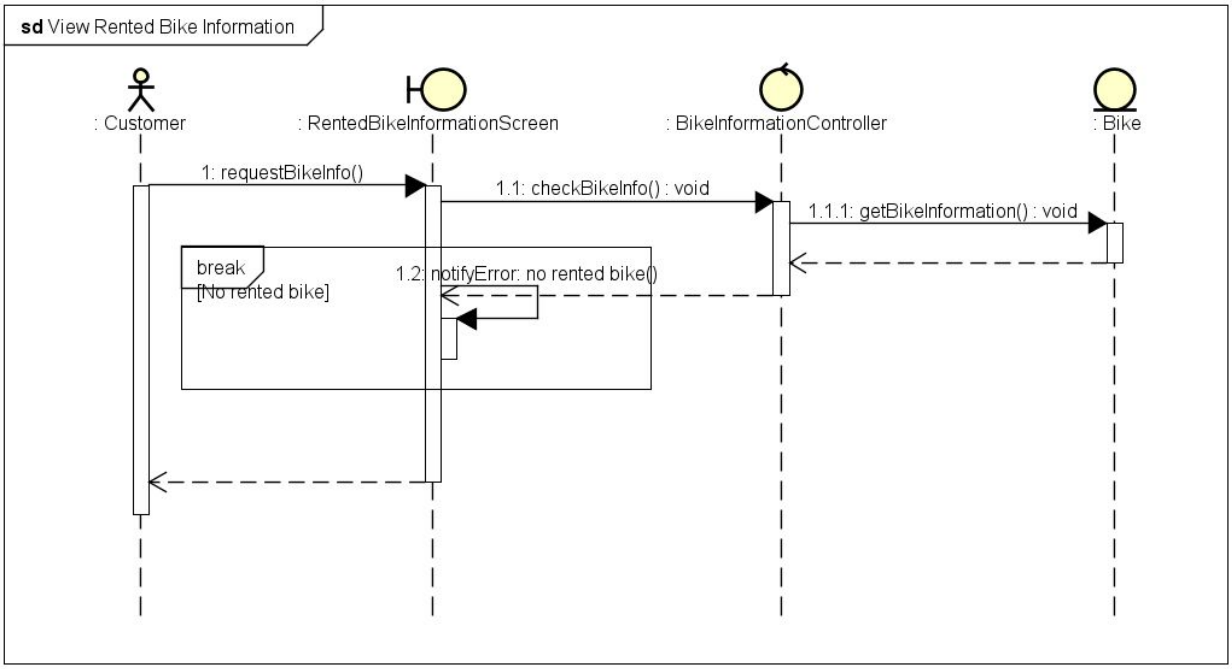
View Bike Details sequence diagram + communication diagram



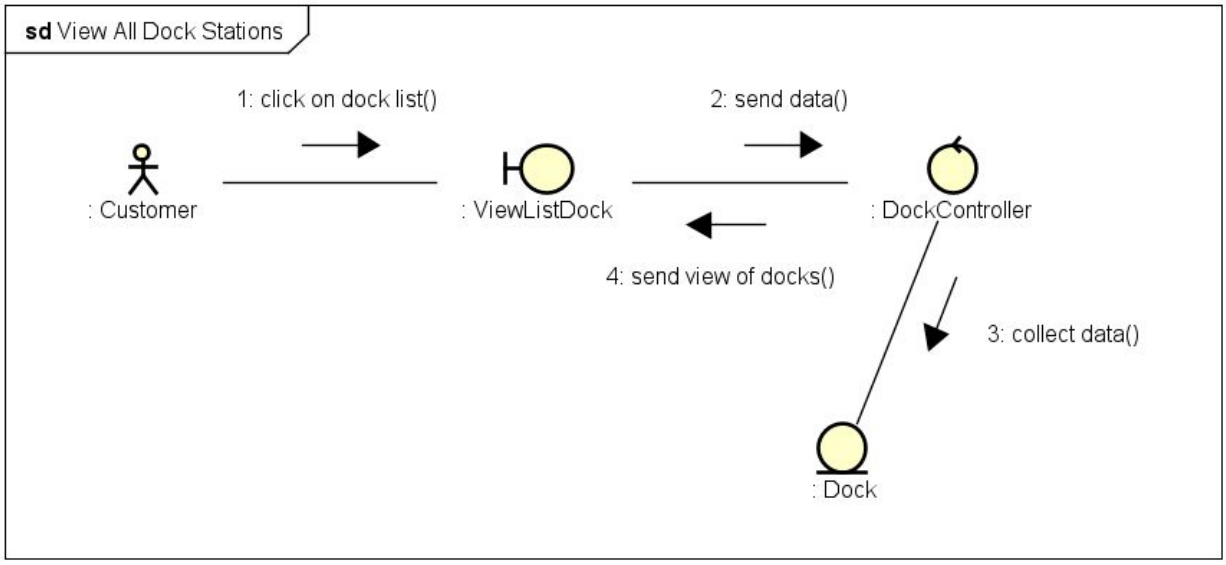


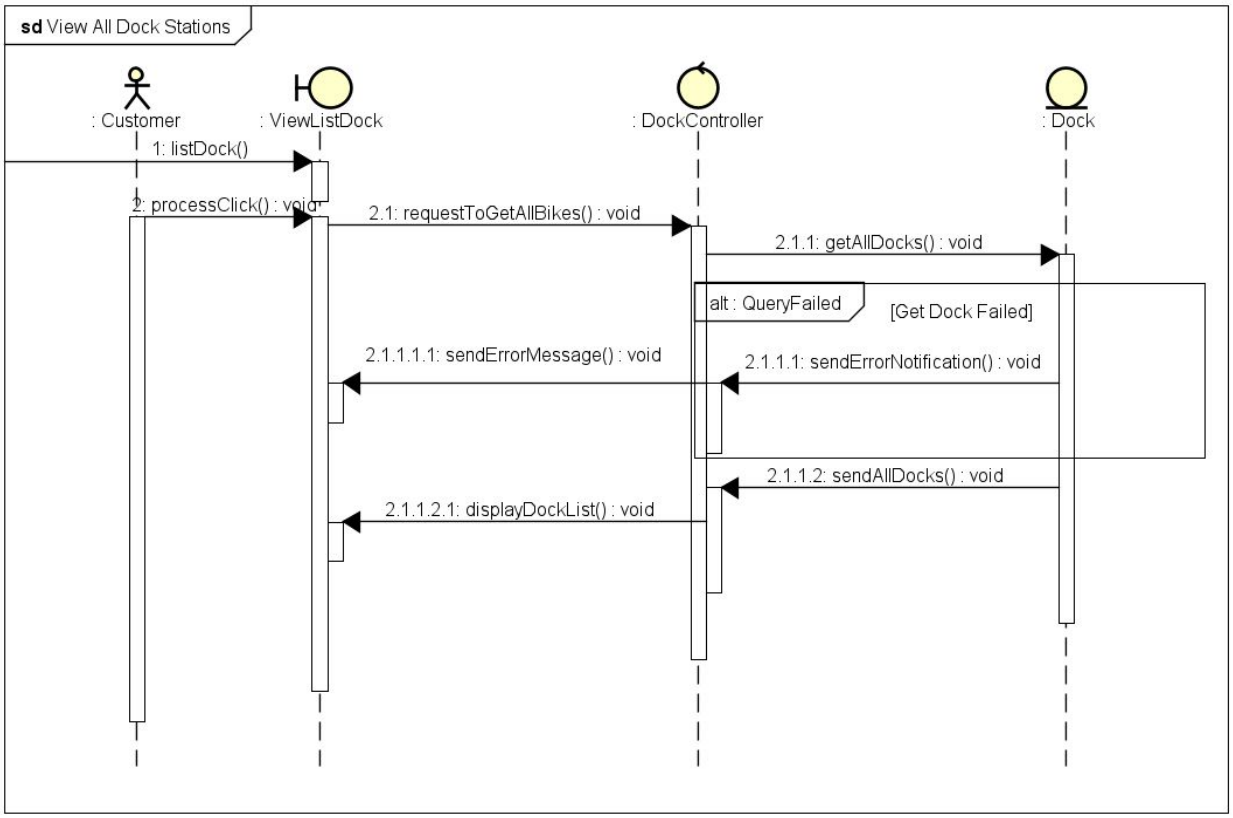
View Rented Bikes Information sequence diagram + communication diagram



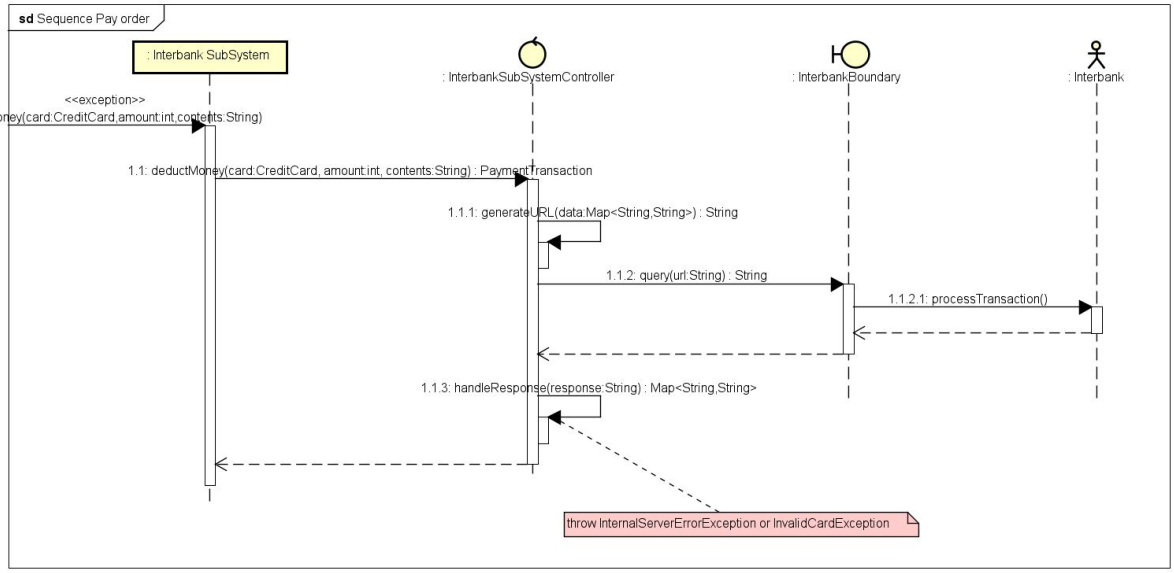


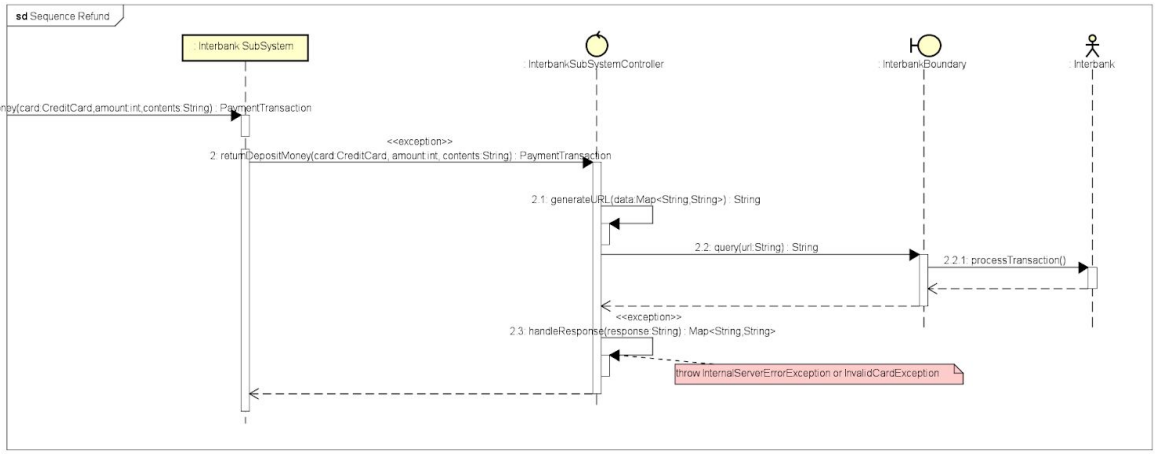
View All Dock Station sequence diagram + communication diagram



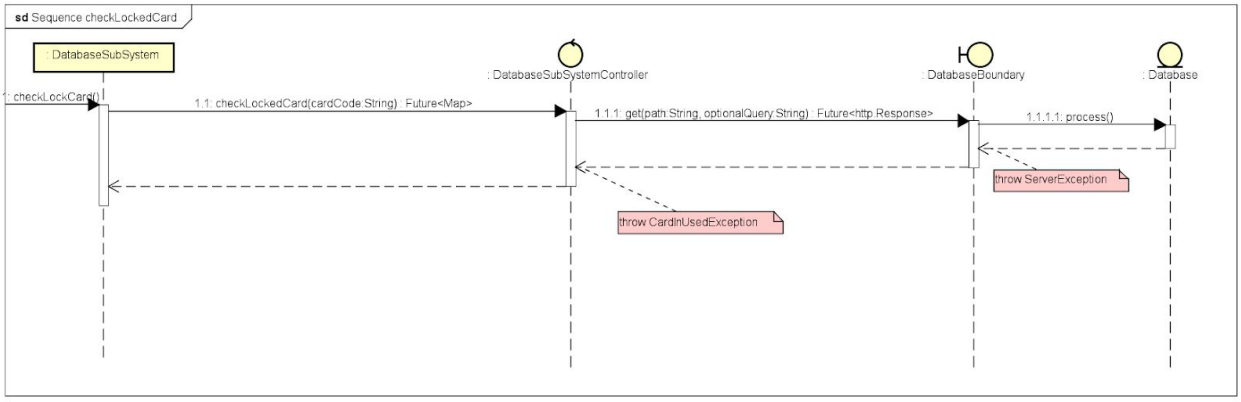


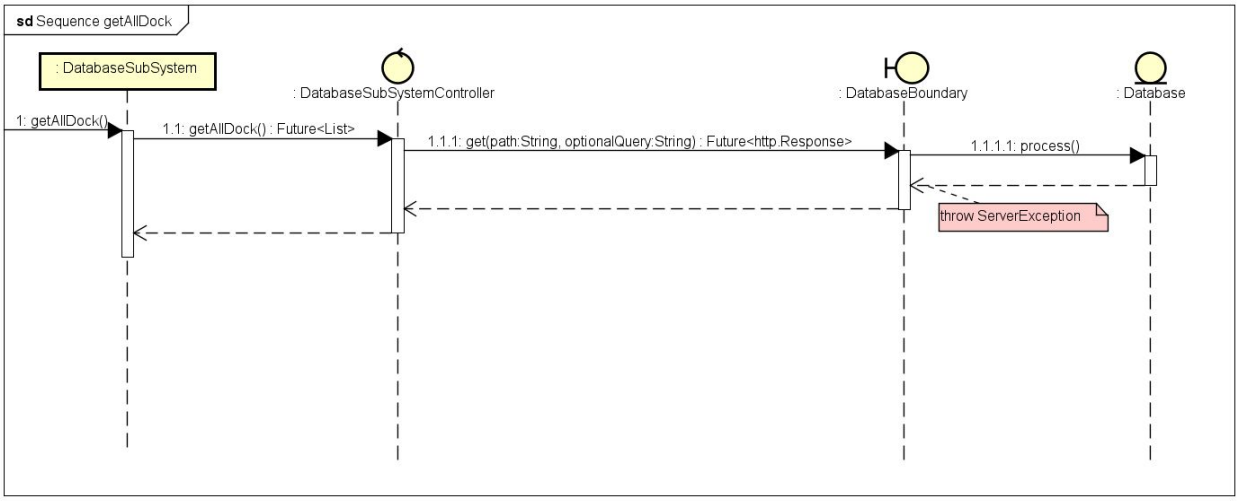
InterbankSubSystem sequence diagrams

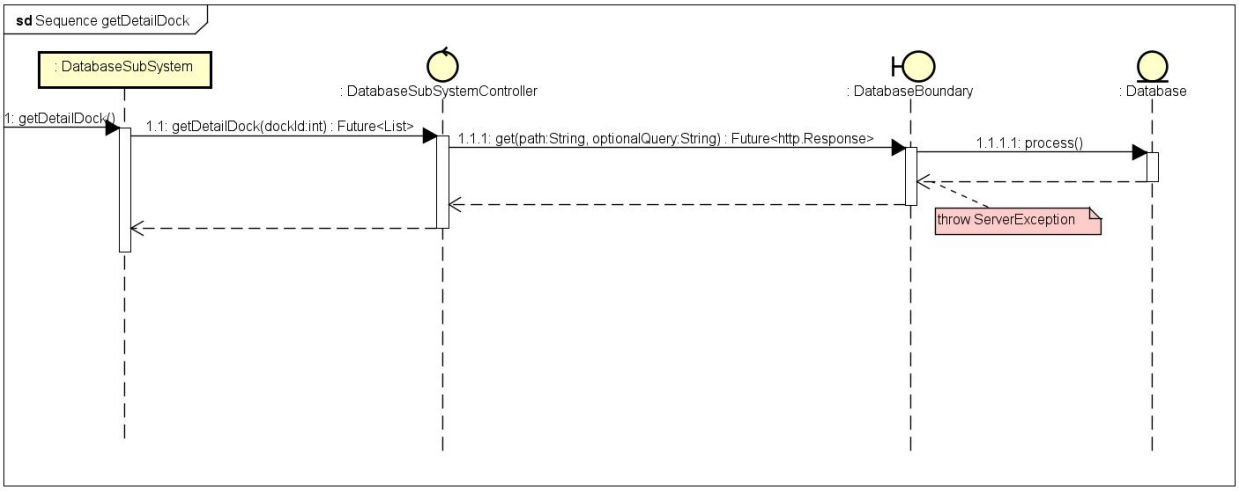


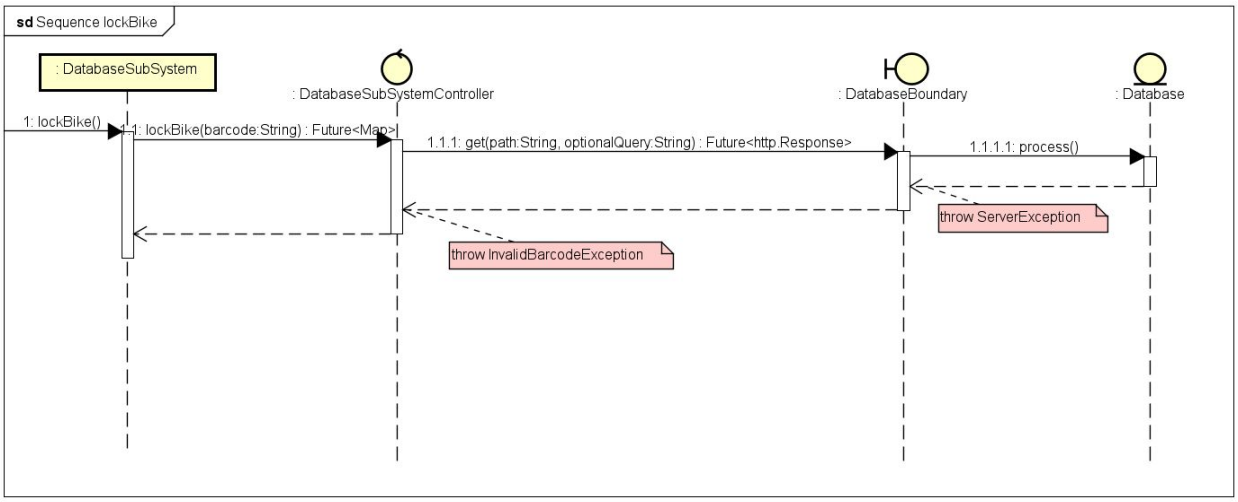


DatabaseSubSystem sequence diagrams





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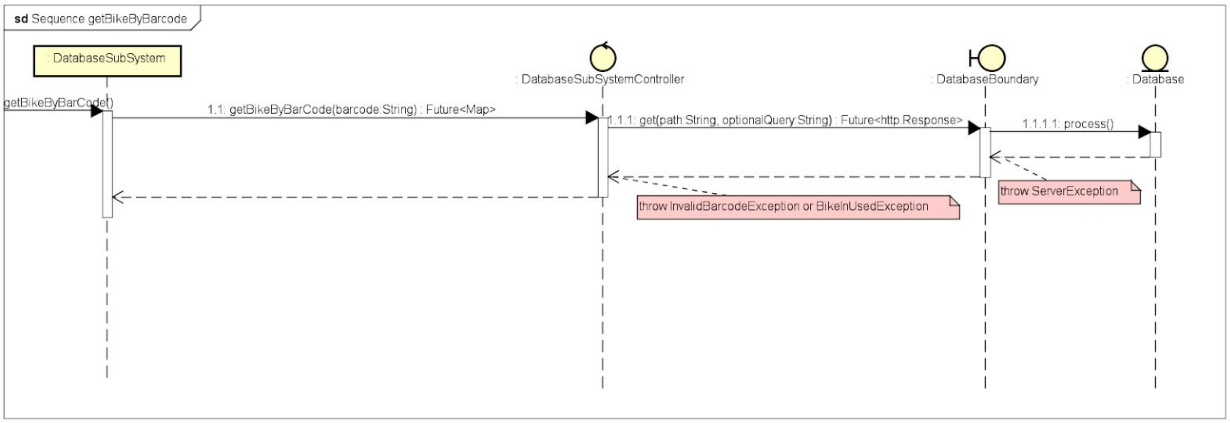
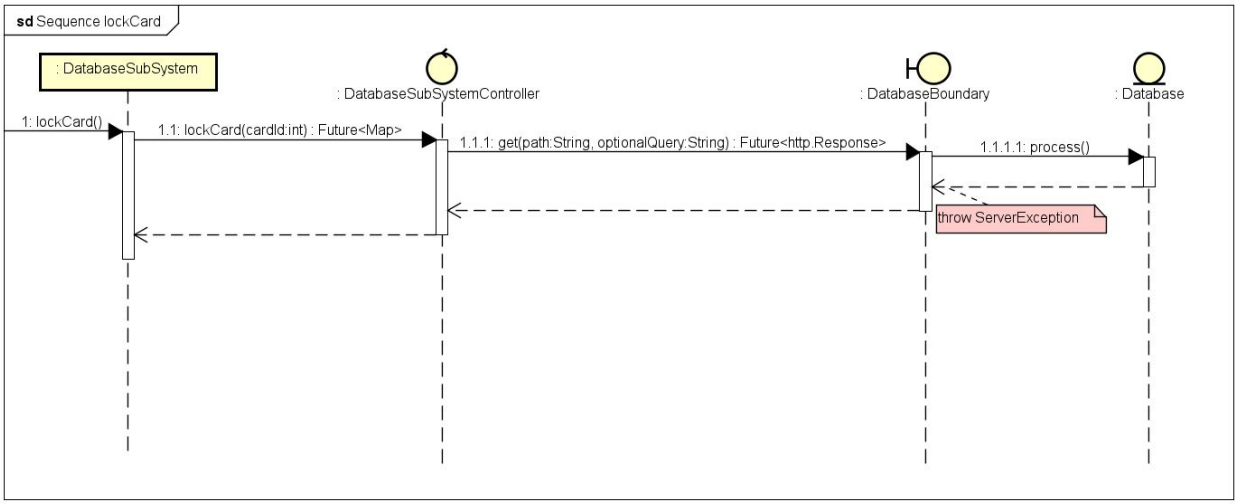
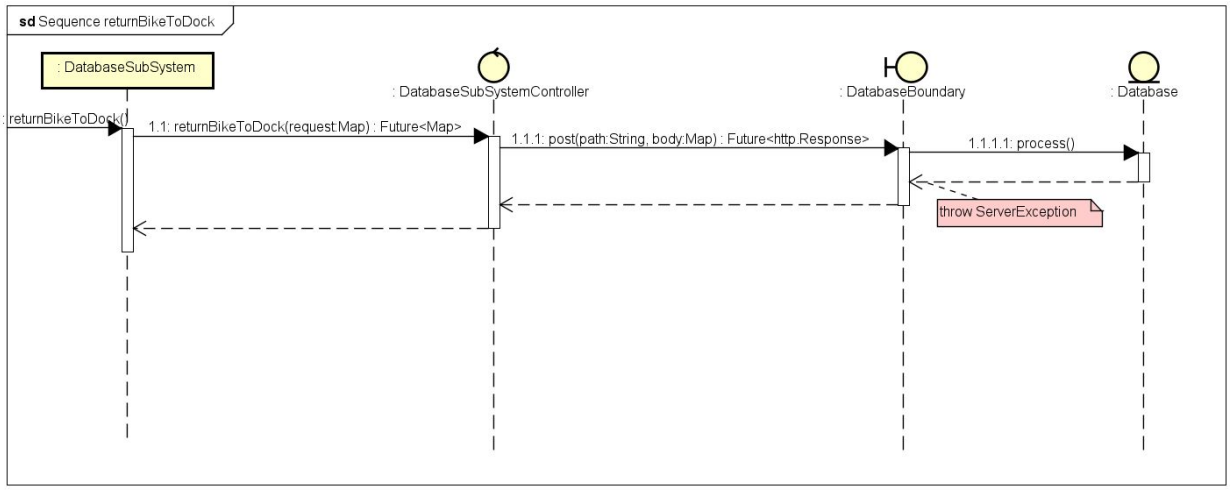
: DatabaseSubSystem
: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: lockBike()
1: lockBike(barcode:String) : Future<Map>
1.1.1: get(path:String, optionalQuery:String) : Future<http.Response>
1.1.1.1: process()
throw ServerException
throw InvalidBarcodeException


sd Sequence getBikeByBarcode
: DatabaseSubSystem
: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: getBikeByBarCode()
1.1: getBikeByBarCode(barcode:String) : Future<Map>
1.1.1: get(path:String, optionalQuery:String) : Future<http.Response>
1.1.1.1: process()
throw ServerException
throw InvalidBarcodeException or BikeInUsedException


sd Sequence lockCard
: DatabaseSubSystem
: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: lockCard()
1.1: lockCard(cardId:int) : Future<Map>
1.1.1: get(path:String, optionalQuery:String) : Future<http.Response>
1.1.1.1: process()
throw ServerException


sd Sequence returnBikeToDock
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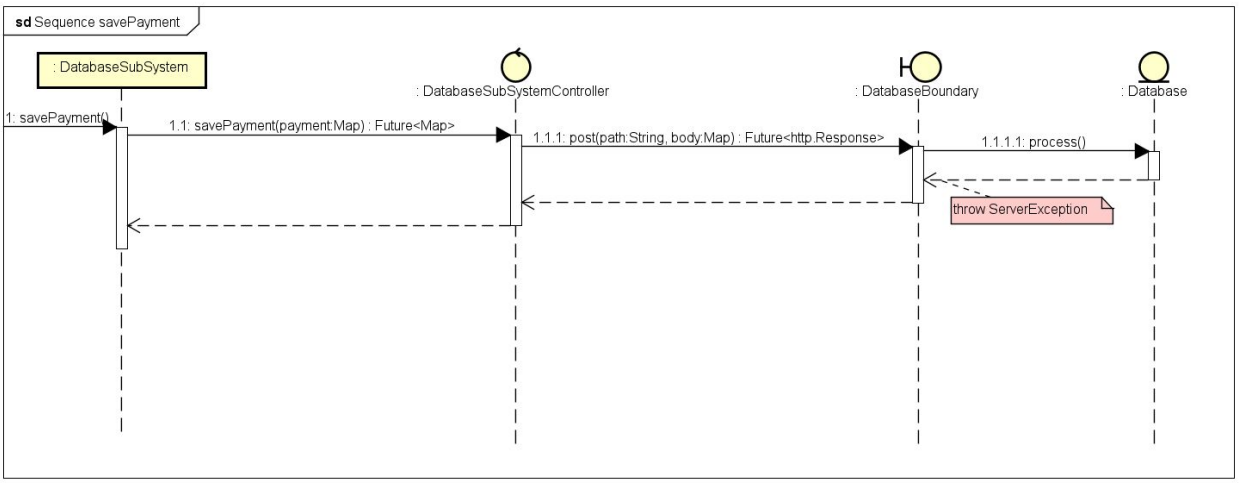
: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: returnBikeToDock()
1.1: returnBikeToDock(request:Map) : Future<Map>
1.1.1: post(path:String, body:Map) : Future<http.Response>
1.1.1.1: process()
throw ServerException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: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: savePayment()
1.1: savePayment(payment:Map) : Future<Map>
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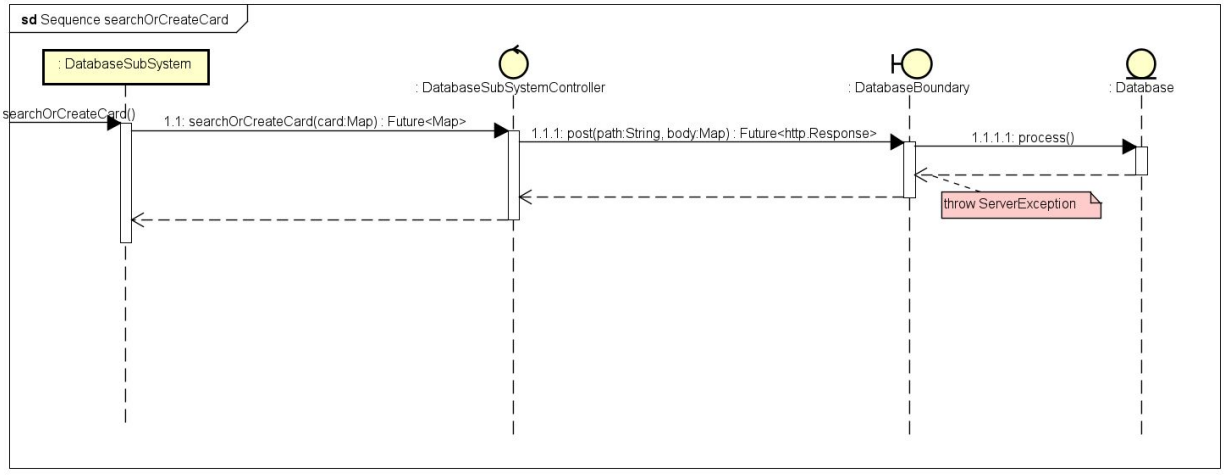
1.1.1.1: process()
throw ServerException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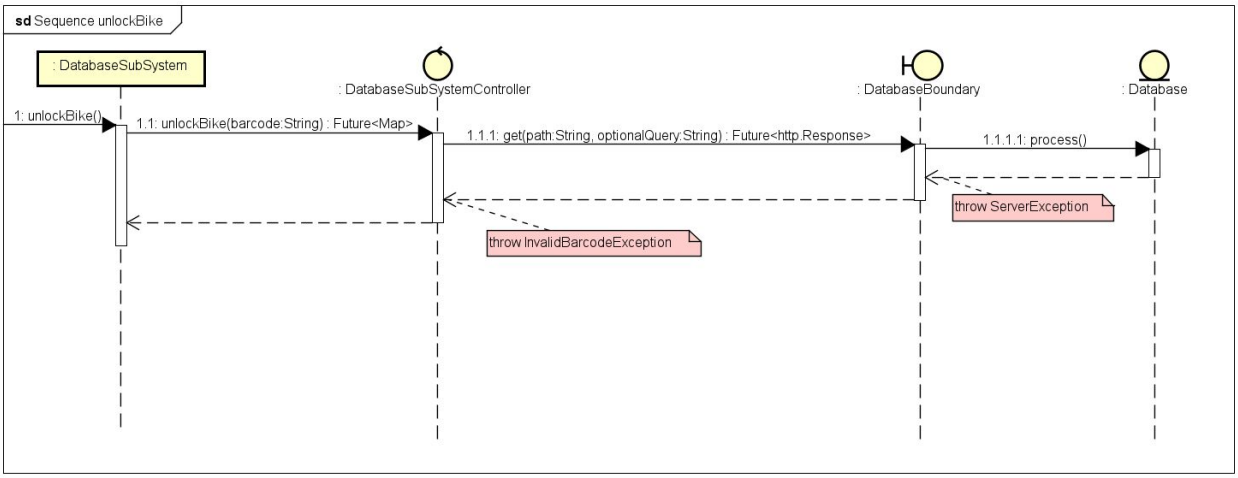
: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: searchOrCreateCard()
1.1: searchOrCreateCard(card:Map) : Future<Map>
1.1.1: post(path:String, body:Map) : Future<http.Response>
1.1.1.1: process()
throw ServerException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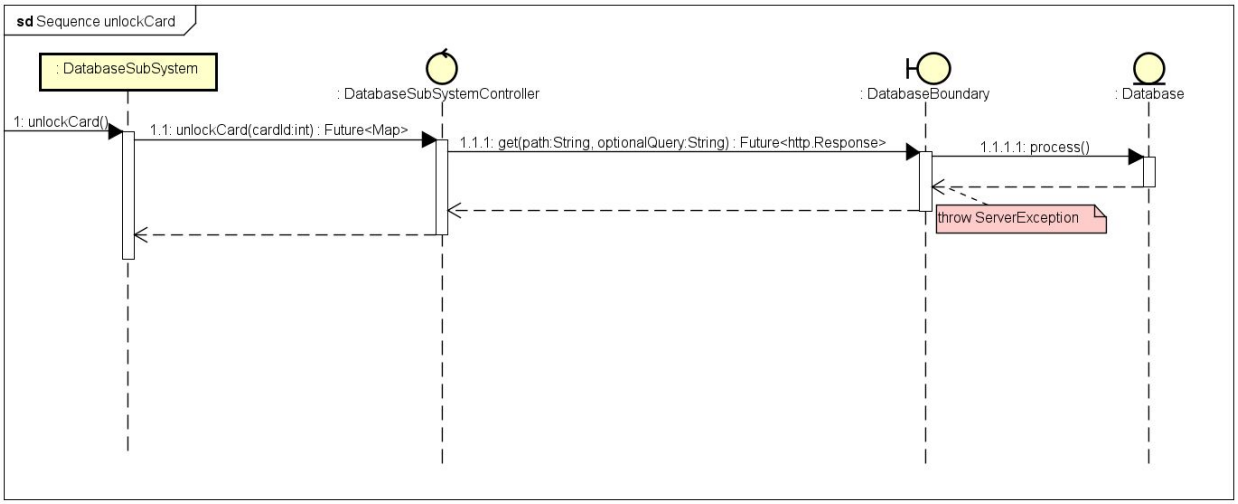
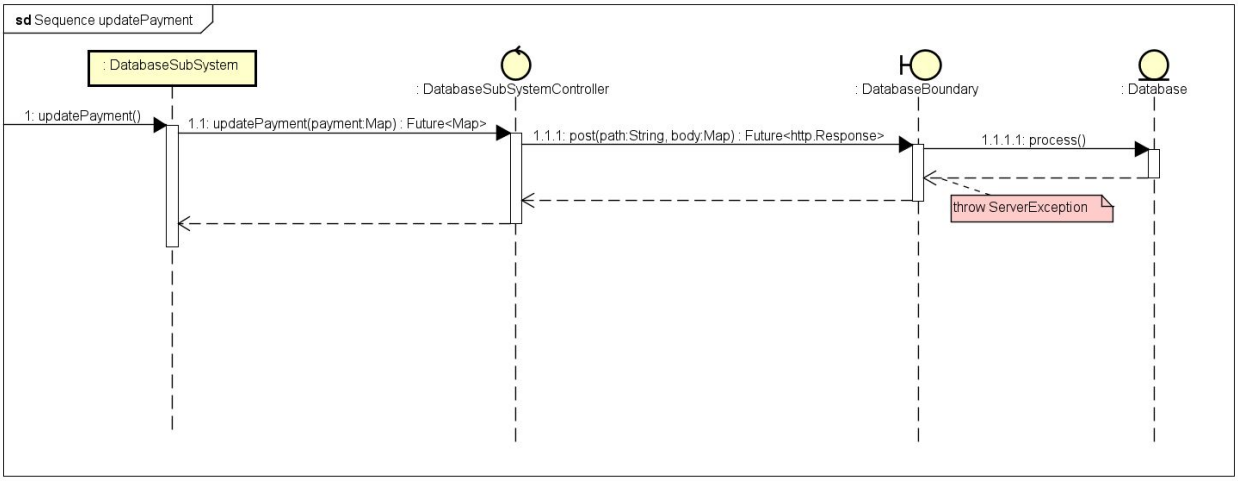
: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: unlockBike()
1.1: unlockBike(barcode:String) : Future<Map>
1.1.1: get(path:String, optionalQuery:String) : Future<http.Response>
1.1.1.1: process()
throw ServerException
throw InvalidBarcodeException


sd Sequence unlockCard
: DatabaseSubSystem
: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: unlockCard()
1.1: unlockCard(cardId:int) : Future<Map>
1.1.1: get(path:String, optionalQuery:String) : Future<http.Response>
1.1.1.1: process()
throw ServerException


sd Sequence updatePayment
: DatabaseSubSystem
: DatabaseSubSystemController
: DatabaseBoundary
: Database
1: updatePayment()
1.1: updatePayment(payment:Map) : Future<Map>
1.1.1: post(path:String, body:Map) : Future<http.Response>
1.1.1.1: process()
throw ServerException

3.3 Analysis Class Diagrams

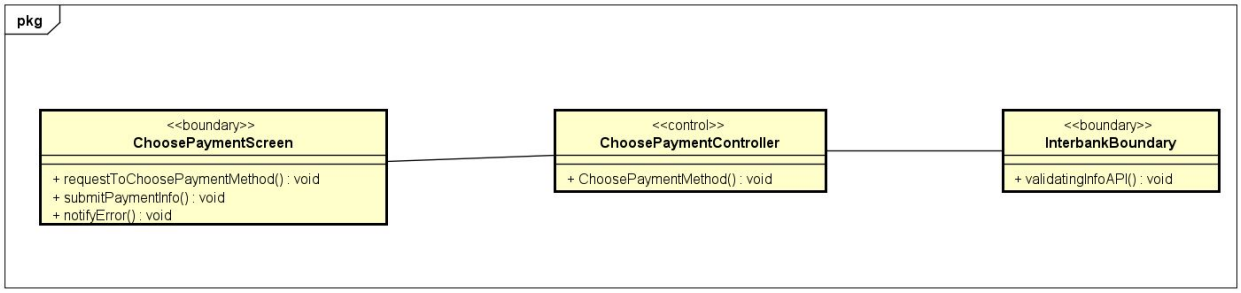


figure 1: choosePaymentMethod class diagram

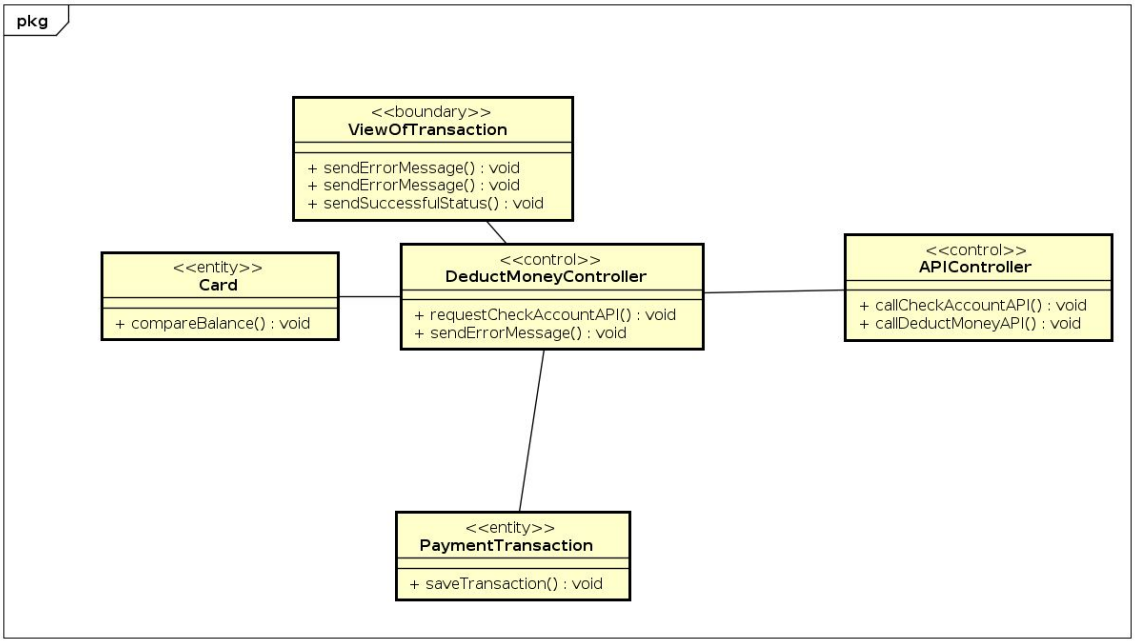


figure 2: deductMoney class diagram

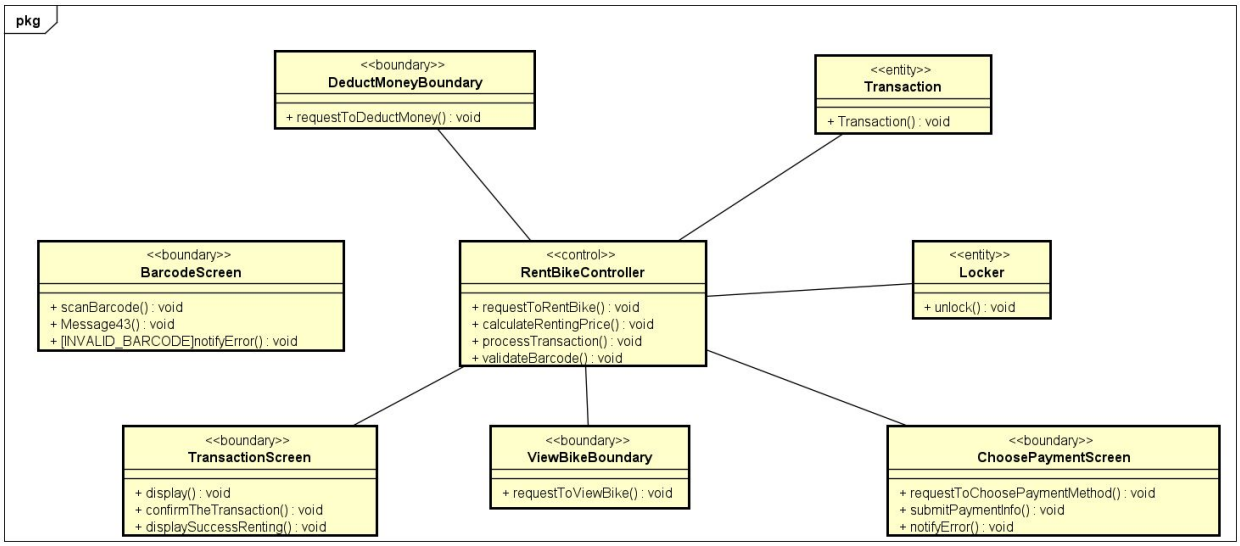


figure 3: rentBike class diagram

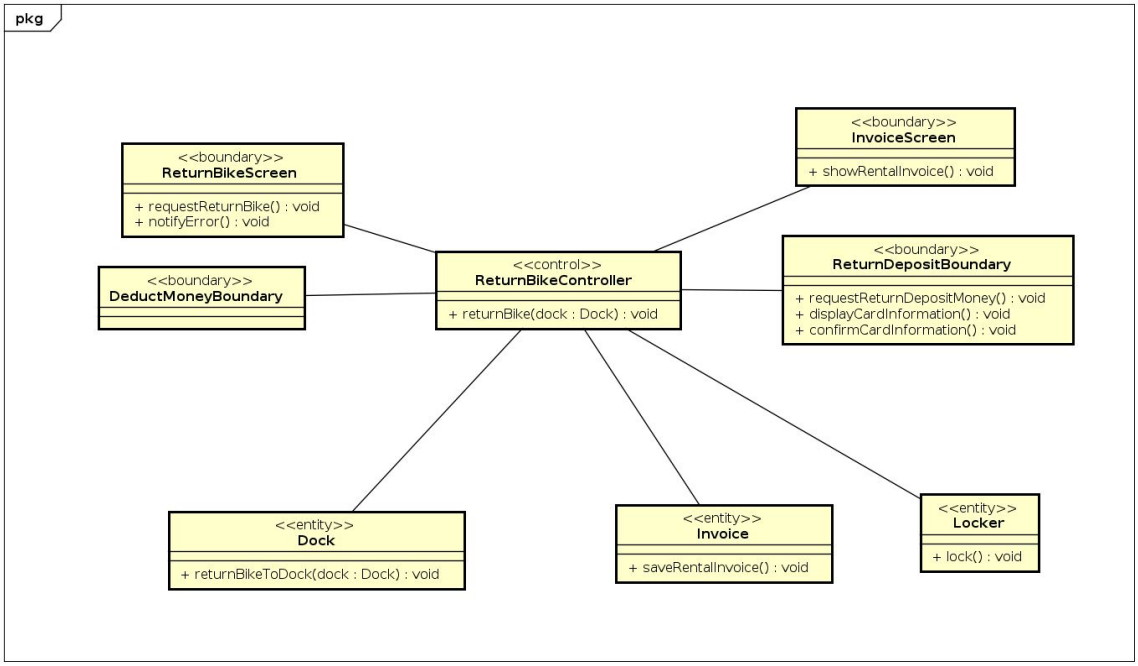


figure 4: returnBike class diagram

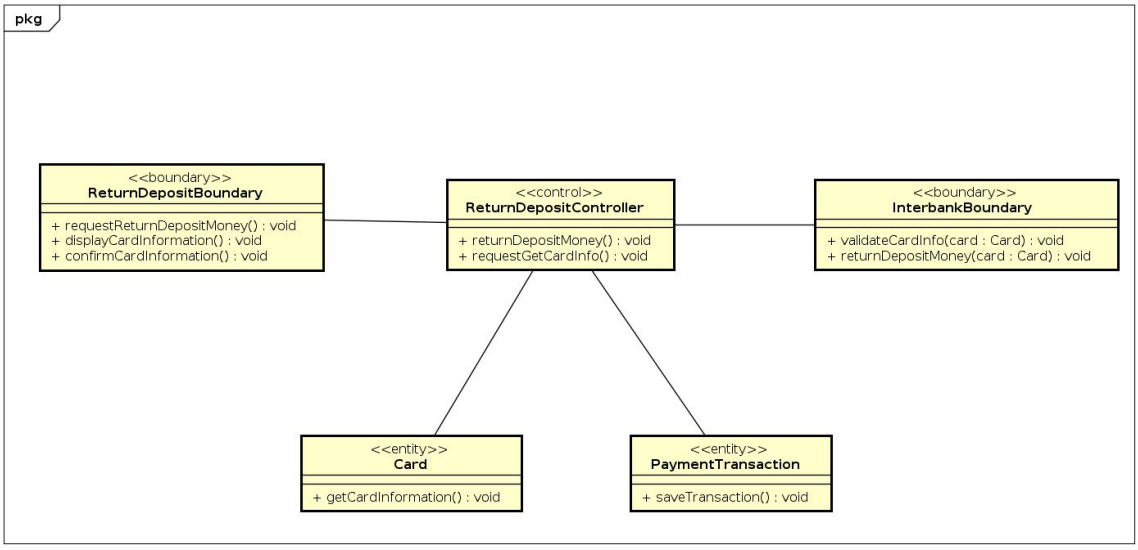


figure 5: returnDepositMoney class diagram

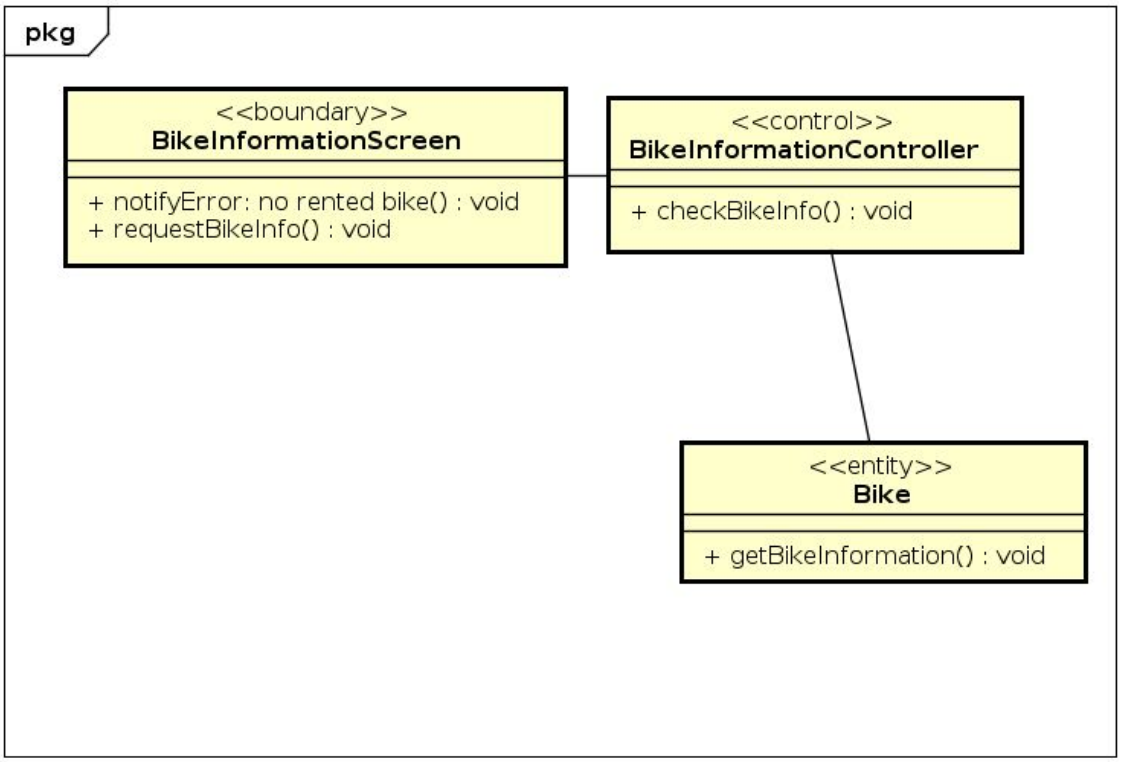


figure 6: viewBikeInformation class diagram

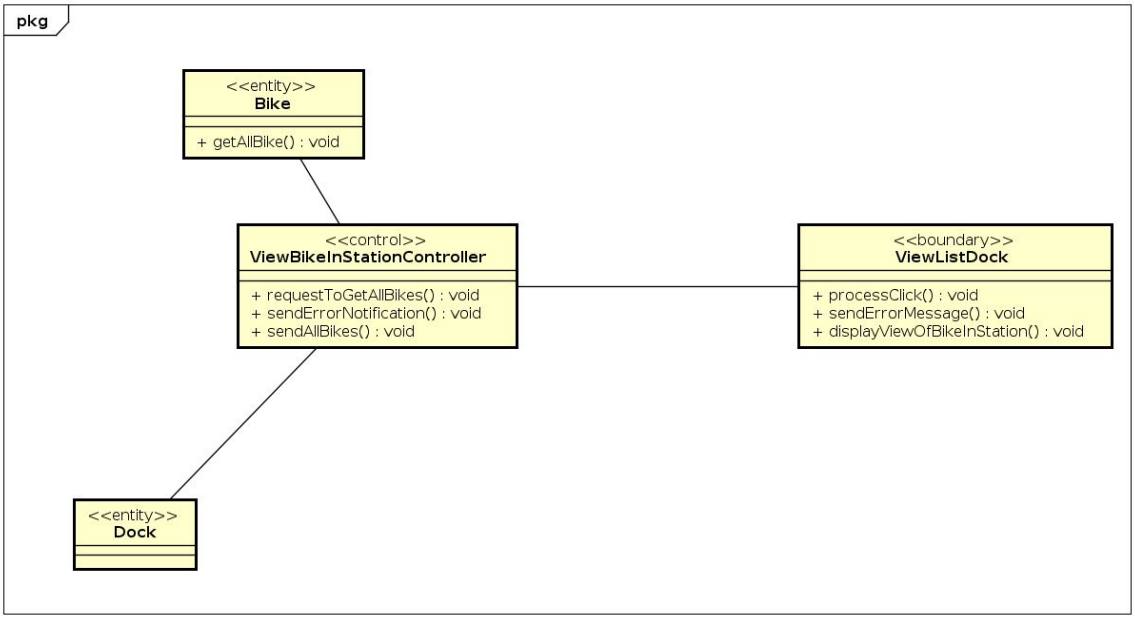
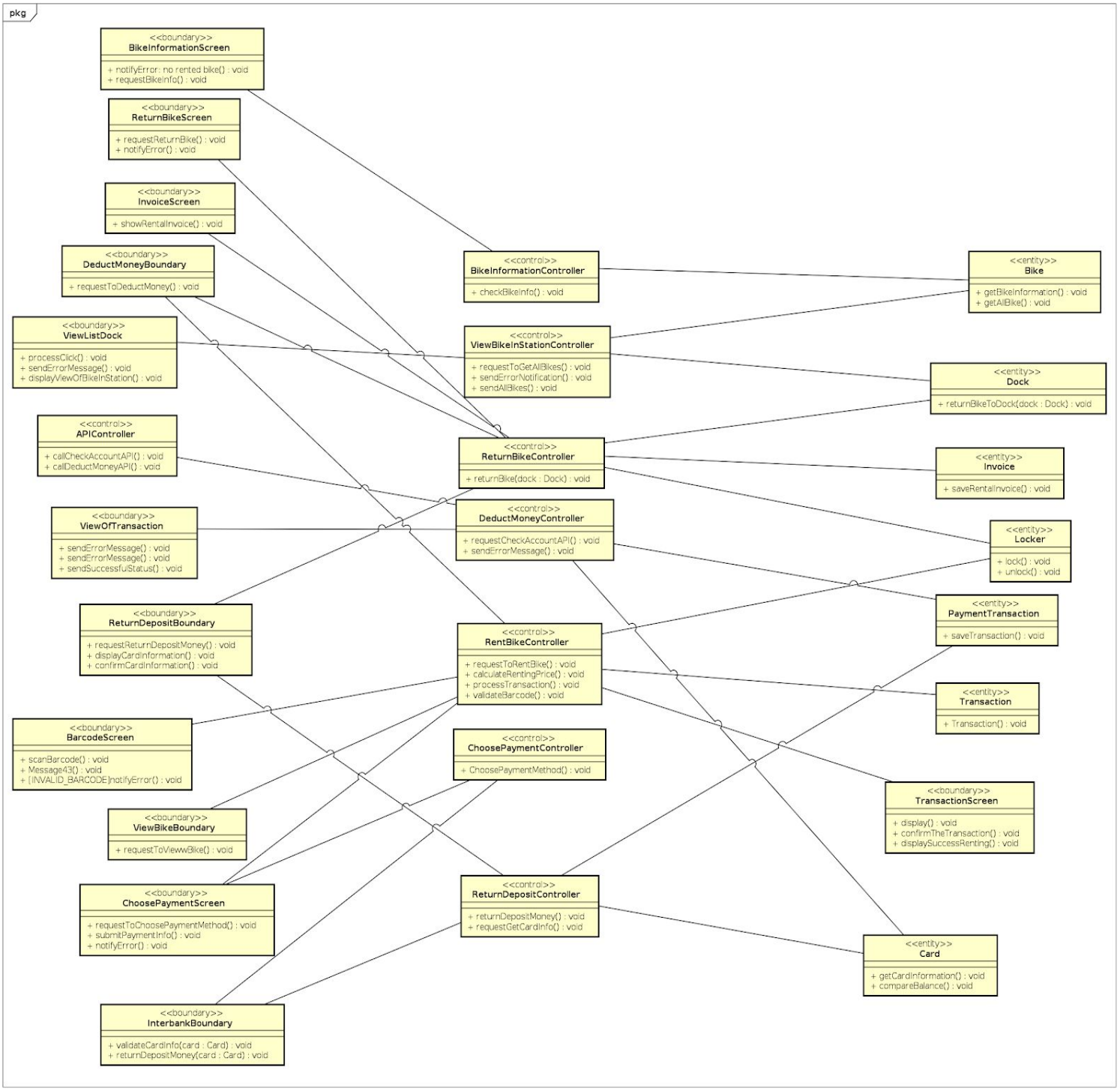


figure 7: viewBikeInStaion class diagram

3.4 Unified Analysis Class Diagram



3.5 Security Software Architecture

<Describe the software components and configuration supporting the security and privacy of the system. Specify the architecture for (1) authentication to validate user identity before allowing access to the system;(2) authorization of users to perform

functional activity once logged into the system, (3) encryption protocol to support the business risks and the nature of information, and (4) logging and auditing design, if required.>

4 Detailed Design

4.1 User Interface Design

<Suppose that you design a Graphical User Interface (GUI)>

4.1.1 Screen Configuration Standardization

4.1.1.1 Screen Configuration Standardizations Display

Number of colors supported: 16,777,216 colors
Resolution: 1792 x 828 - Phone Resolution *pixels*

4.1.1.2 Screen

Location of standard buttons: At the bottom (vertically) and in the middle (horizontally) of the frame

Location of the messages: Starting from the top vertically and in the middle horizontally of the frame down to the bottom.

Display of the screen title: The title is located at the top of the frame in the middle.

Consistency in expression of alphanumeric numbers: comma for separator of thousand while strings only consist of characters, digits, commas, dots, spaces, underscores, and hyphen symbol.

4.1.1.3 Control

Size of the text: medium size (mostly 24px). Font: Roboto Sans. Color: #000000

Input check process: Should check if it is empty or not. Next, check if the input is in the correct format or not

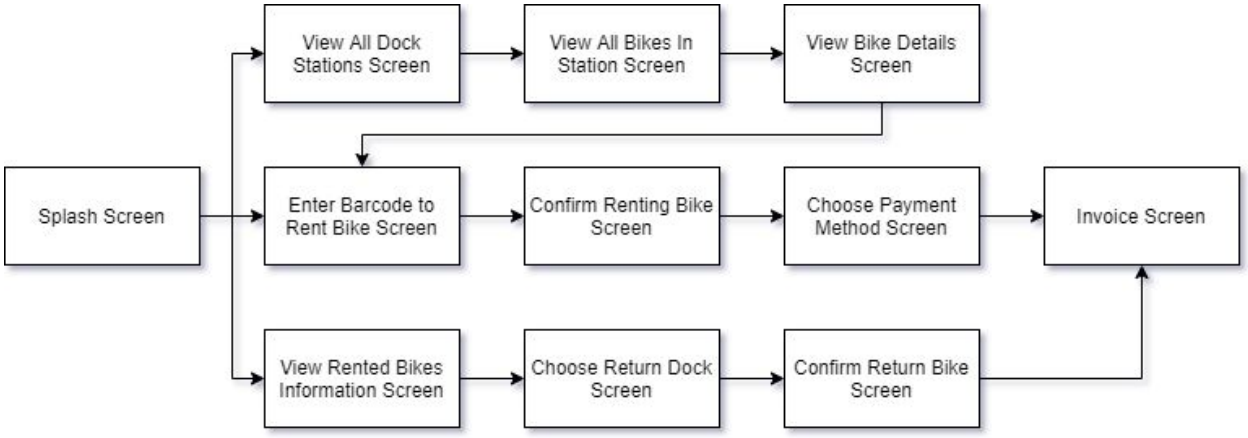
Sequence of moving the focus: After the opening screen, the app will start with a splash screen, and then the first screen (home screen) will appear.

4.1.1.4 Sequences of the system screens:

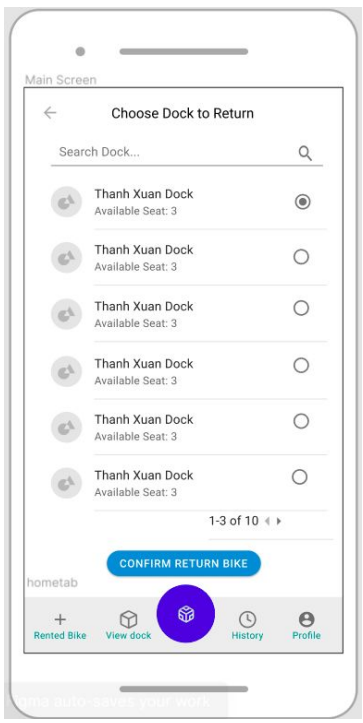
1. Splash Screen
2. View All Dock Stations Screen
3. View All Bikes In Station Screen
4. View Bike Details Screen
5. Enter Barcode to Rent Bike Screen
6. Confirm Renting Bike Screen

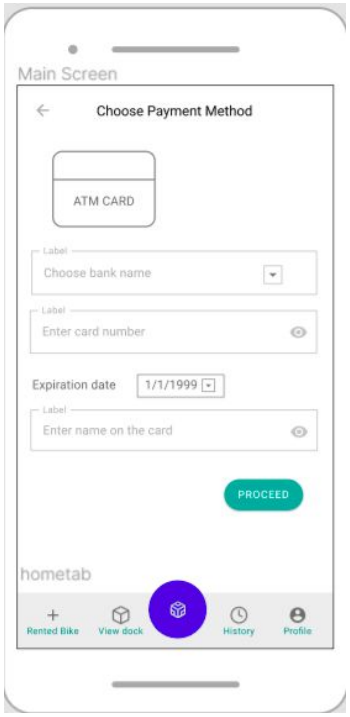
7. Choose Payment Method Screen
8. View Rented Bikes Information Screen
9. Return Bike Screen
10. Choose Return Dock Screen
11. Confirm Return Bike Screen
12. Invoice Screen

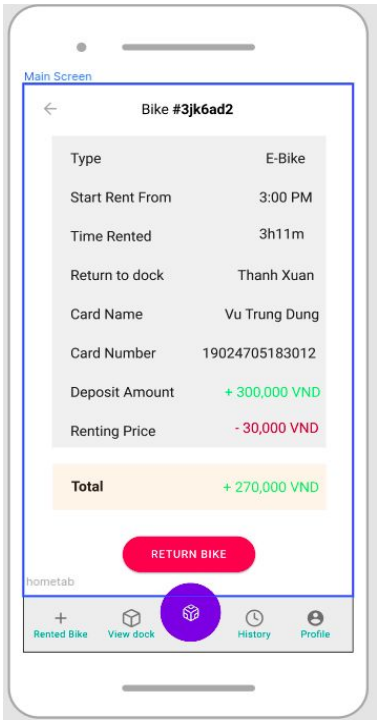
4.1.2 Screen Transition Diagrams

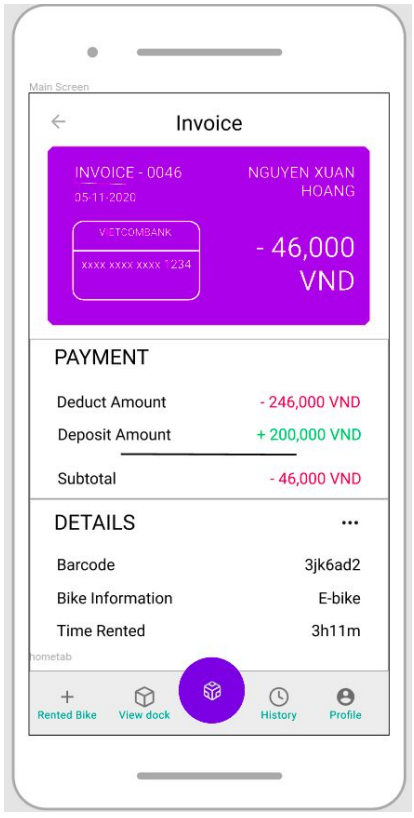


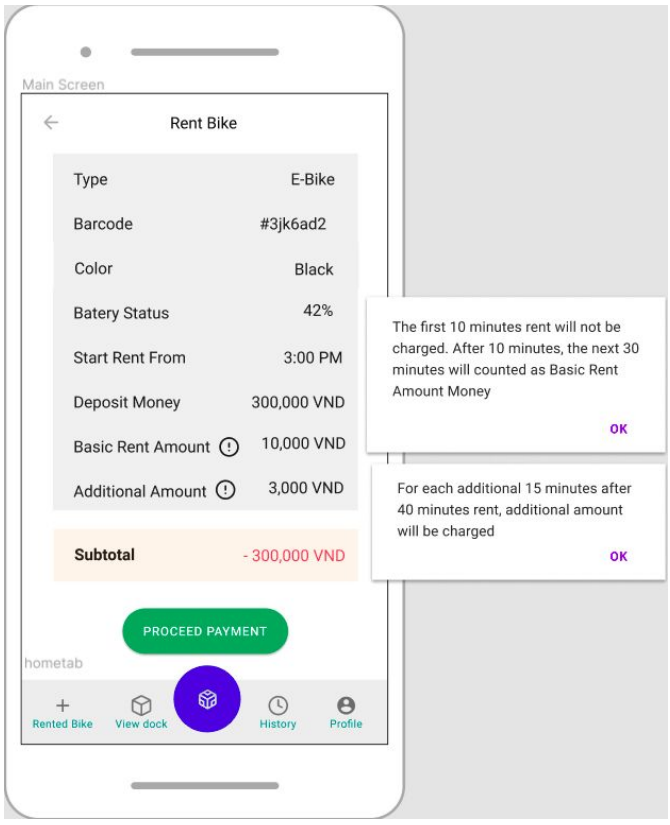
4.1.3 Screen Specifications

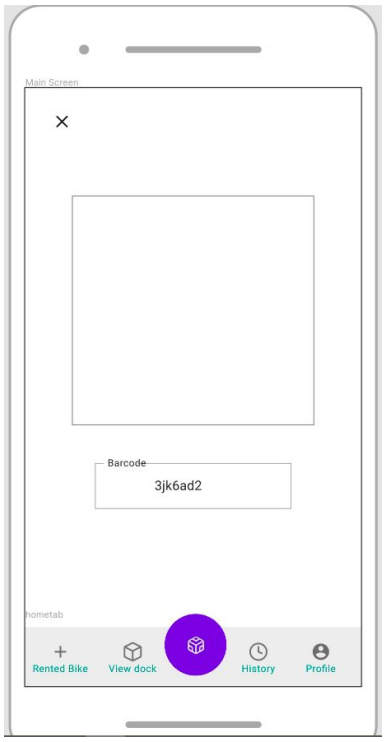




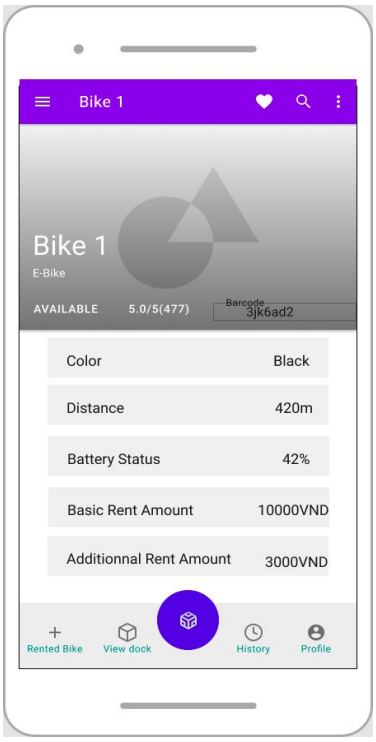


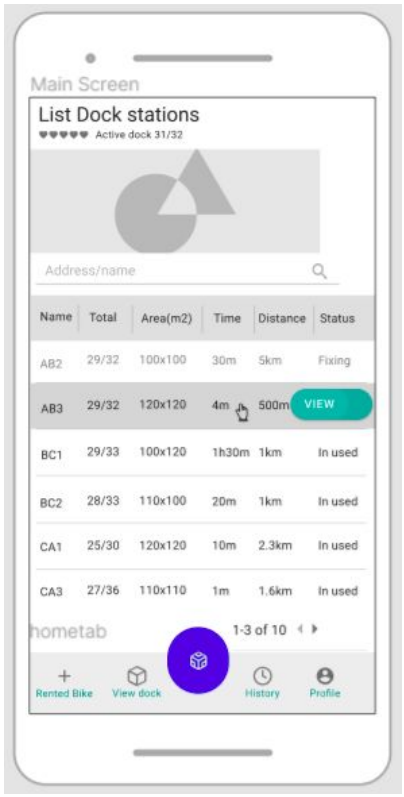


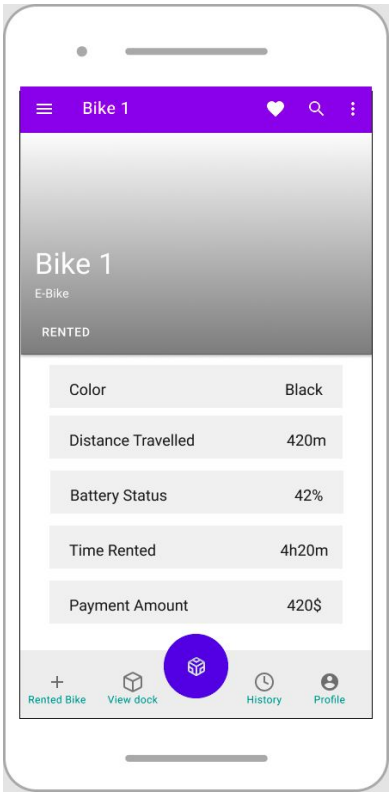



Main Screen
Barcode
3jk6ad2
hometab
Rented Bike
View dock
History
Profile


Main Screen
List bikes
Avaiable bikes 8/56
BikeID Type Rating color Distance Status
CZ43 standard black fixing
AK47 Electric black 10km
DE12 twin white 1km in used
USP2 electric black 15km avaiable
AWM1 electric white 15km
UZI2 standard black avaiable
hometab
1-3 of 10
Rented Bike
View dock
History
Profile


Bike 1
Bike 1
E-Bike
AVAILABLE
5.0/5(477)
Barcode
3jk6ad2
Color Black
Distance 420m
Battery Status 42%
Basic Rent Amount 10000VND
Additionnal Rent Amount 3000VND
Rented Bike
View dock
History
Profile

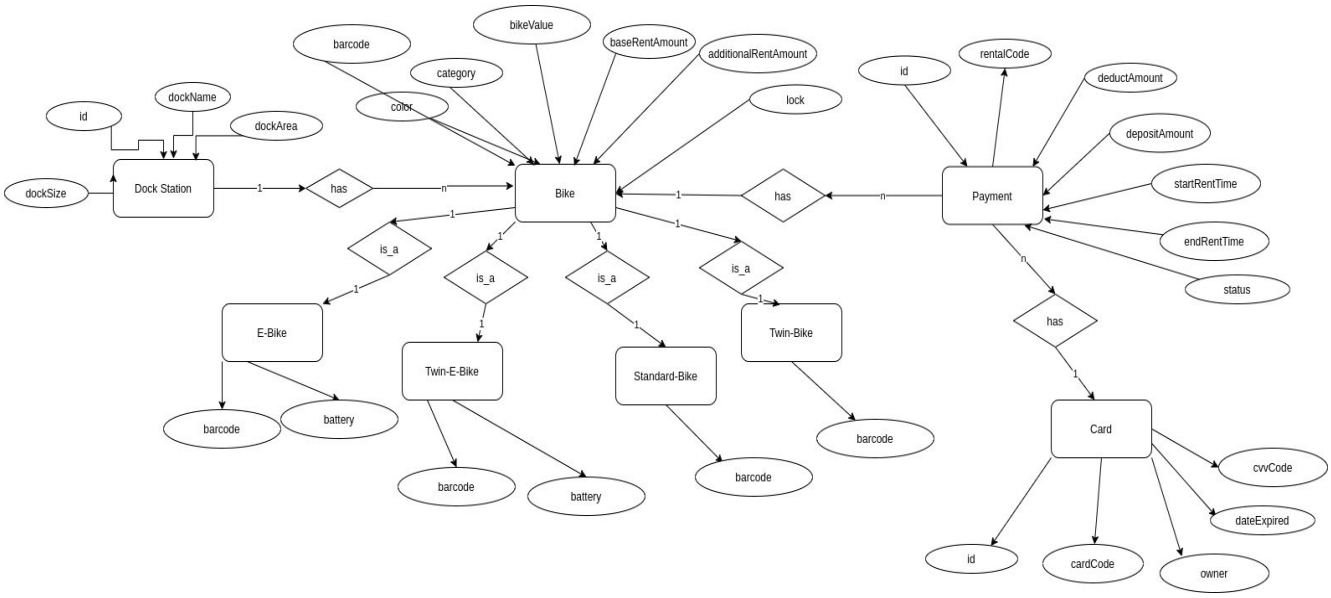

Main Screen
List Dock stations
Active dock 31/32
Address/name
Name Total Area(m2) Time Distance Status
AB2 29/32 100x100 30m 5km Fixing
AB3 29/32 120x120 4m 500m VIEW
BC1 29/33 100x120 1h30m 1km In used
BC2 28/33 110x100 20m 1km In used
CA1 25/30 120x120 10m 2.3km In used
CA3 27/36 110x110 1m 1.6km In used
hometab
1-3 of 10
Rented Bike
View dock
History
Profile


Bike 1
Bike 1
E-Bike
RENTED
Color Black
Distance Travelled 420m
Battery Status 42%
Time Rented 4h20m
Payment Amount 420$
Rented Bike
View dock
History
Profile

4.2 Data Modeling

4.2.1 Conceptual Data Modeling

<E-R Diagram image and description of entities and relationships>

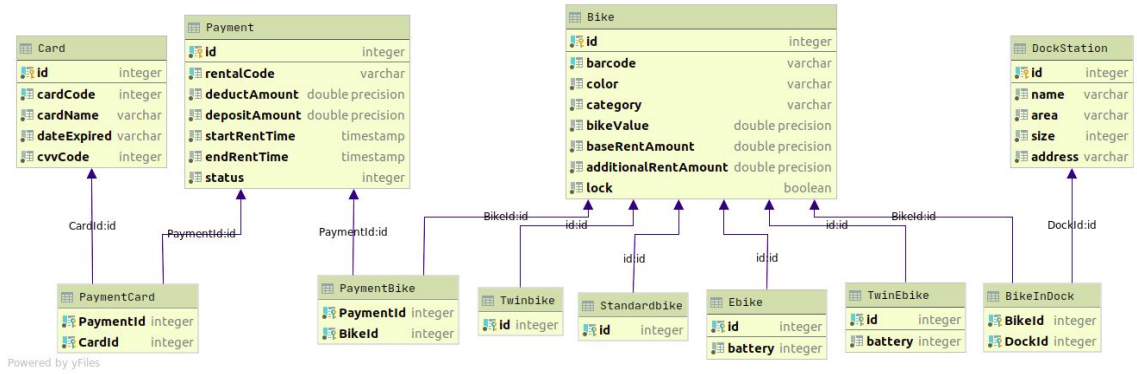


4.2.2 Database Design

4.2.2.1 Database Management Systems

- Database Management System: PostgreSQL
- PostgreSQL follows SQL standards but does not conflict with traditional features or could lead to harmful architectural decisions.
- PostgreSQL is open source, powerful DBMS and there are a wide variety of communities. Therefore, it will be much easier to find a solution when having concern or error.

4.2.2.2 Logical Data Model



4.2.2.3 Physical Data Model

- **BikeInfo**

#	*PK*	*FK*	*Column Name*	*Data Type*	*Mandatory*	*Description*
1	x	x	id	integer	Yes	Payment id
2			bikeValue	double	Yes	Bike id
			baseRentAmount	double	Yes	Base rent amount
			addRentAmount	double	Yes	Add rent amount
			saddle	integer	Yes	saddle
			pedal	integer	Yes	pedal
			rear	integer	Yes	rear

-

#	*PK*	*FK*	*Column Name*	*Data Type*	*Mandatory*	*Description*
1.	x		Id	Integer	Yes	ID, auto increment
2.			Name	VARCHAR	Yes	Name of dock
3.			area	VARCHAR	Yes	Area of the dock
4.			size	Integer	Yes	Max size of dock

5.			Address	VARCHAR	Yes	Address of dock

- **Card**

#	*PK*	*FK*	*Column Name*	*Data Type*	*Mandatory*	*Description*
1.	x	x	id	Integer	Yes	ID
2.			cardCode	VARCHAR	Yes	Card's Code
3.			cardName	VARCHAR	Yes	Name of the card's owner
4.			cvvCode	Integer	Yes	CVV Code of the Card
5.			dateExpired	VARCHAR	Yes	Card's Expiration Date

- **Payment**

#	*PK*	*FK*	*Column Name*	*Data Type*	*Mandatory*	*Description*
1	x		id	integer	yes	Payment id
2			rentalCode	Integer	yes	Rental code
3			rentAmount	double	Yes	Rent amount
4			DepositAmount	double	yes	Deposit amount
5			startRentTime	TIMESTAMP	yes	Starting rent time
6			endRentTime	TIMESTAMP	yes	Ending rent time
7		x	statusId	integer	yes	Id of status transaction
8		x	bikeId	integer		
9		x	cardId	integer		

- **PaymentStatus**

#	*PK*	*FK*	*Column Name*	*Data Type*	*Mandatory*	*Description*
1.	x	x	id	Integer	Yes	Payment ID
2.	x		status	varchar	Yes	Status of payment

- **Bike**

#	*PK*	*FK*	*Column Name*	*Data Type*	*Mandatory*	*Description*
1	x		Id	Integer	Yes	ID, auto increment
2			barcode	VARCHAR	Yes	Bike's barcode
3			color	VARCHAR	Yes	Bike's color
4			category	VARCHAR	Yes	Bike's category
5			lockBike	Boolean	Yes	Bike is locked or not
6		x	dockId	integer	Yes	Bike's dock Id
7		x	bikeInfoId	Integer	Yes	Bike's information ID

•

#	*PK*	*FK*	*Column Name*	*Data Type*	*Mandatory*	*Description*
1.	x	x	id	Integer	Yes	Bike Id
2.			battery	Integer	Yes	Bike's battery status

•

#	PK	FK	Column Name	Data Type	Mandatory	Description
1.	x	x	id	Integer	Yes	Bike Id
2.			battery	Integer	Yes	Bike's battery status

•

#	PK	FK	Column Name	Data Type	Mandatory	Description
1.	x	x	id	Integer	Yes	Bike Id

•

#	PK	FK	Column Name	Data Type	Mandatory	Description
1.	x	x	id	Integer	Yes	Bike Id

4.2.2.4 Database script

```
create table "ecoBikeSystem"."DockStation"
(
    id      serial  not null,
    name    VARCHAR not null,
```

```
    area     VARCHAR not null,
    size     int     not null,
    address VARCHAR not null
);

create unique index dockstation_id_uindex
    on "ecoBikeSystem"."DockStation" (id);

alter table "ecoBikeSystem"."DockStation"
    add constraint dockstation_pk
    primary key (id);
create table "ecoBikeSystem"."BikeInfo"
(
    id        serial PRIMARY KEY not null,
    bikeValue       FLOAT          not null,
    baseRentAmount FLOAT              not null,
    addRentAmount  FLOAT              not null,
    saddle          INT              not null,
    pedal           INT              not null,
    rear            INT              not null
);

create table "ecoBikeSystem"."Bike"
(
    id        serial             not null,
    barcode         VARCHAR              not null,
```

```
        color    VARCHAR                not null,
        category   VARCHAR              not null,
        lockbike   BOOLEAN default FALSE not null,
        "dockId"   int                  not null
        constraint bikeindock_dockstation_id_fk
        references "ecoBikeSystem"."DockStation"
        on update cascade on delete cascade,
        bikeInfold int                  not null
        constraint bikeInfo_id_fk
        references "ecoBikeSystem"."BikeInfo"
        on update cascade on delete cascade
);

create unique index bike_barcode_uindex
        on "ecoBikeSystem"."Bike" (barcode);

create unique index bike_id_uindex
        on "ecoBikeSystem"."Bike" (id);

alter table "ecoBikeSystem"."Bike"
        add constraint bike_pk
        primary key (id);



create table "ecoBikeSystem"."Card"
```

```
(
        id        serial              not null,
        "cardCode"    VARCHAR                 not null,
        "cardName"    VARCHAR                 not null,
        "dateExpired" VARCHAR                 not null,
        "cvvCode"     int                 not null,
        lock              boolean default false not null
);

create unique index card_cardcode_uindex
        on "ecoBikeSystem"."Card" ("cardCode");

create unique index card_id_uindex
        on "ecoBikeSystem"."Card" (id);

alter table "ecoBikeSystem"."Card"
        add constraint card_pk
        primary key (id);

create table "ecoBikeSystem"."PaymentStatus"
(
        id        int     not null
        constraint paymentStatus_pk
        primary key,
        status VARCHAR NOT NULL
```

```
);
create table "ecoBikeSystem"."Payment"
(
        id                  serial   not null,
    "rentalCode"    VARCHAR   not null,
    "rentAmount"    float         not null,
        "depositAmount" float         not null,
        "startRentTime" TIMESTAMP not null,
    "endRentTime"   TIMESTAMP not null,
        statusId          int       not null
        constraint paymentStatus_payment_fk
        references "ecoBikeSystem"."PaymentStatus"
        on update cascade on delete cascade,
        "bikeId"          int       not null
        constraint paymentbike_bike_id_fk
        references "ecoBikeSystem"."Bike"
        on update cascade on delete cascade,
        "cardId"          int      not null
        constraint paymentcard_card_id_fk
        references "ecoBikeSystem"."Card"
        on update cascade on delete cascade
);

create unique index payment_id_uindex
        on "ecoBikeSystem"."Payment" (id);
```

```
create unique index payment_rentalcode_uindex
        on "ecoBikeSystem"."Payment" ("rentalCode");

alter table "ecoBikeSystem"."Payment"
        add constraint payment_pk
        primary key (id);


create table "ecoBikeSystem"."Ebike"
(
        id        int not null
        constraint ebike_pk
        primary key
        constraint ebike_bike_id_fk
        references "ecoBikeSystem"."Bike"
        on update cascade on delete cascade,
        battery int not null
);

create table "ecoBikeSystem"."TwinEbike"
(
        id      int not null
        constraint twinebike_pk
        primary key
        constraint twinebike_bike_id_fk
        references "ecoBikeSystem"."Bike"
```

```
        on update cascade on delete cascade,
        battery int not null
);

create table "ecoBikeSystem"."Standardbike"
(
        id int not null
        constraint standardbike_pk
        primary key
        constraint standardbike_bike_id_fk
        references "ecoBikeSystem"."Bike"
        on update cascade on delete cascade
);

create table "ecoBikeSystem"."Twinbike"
(
        id int not null
        constraint twinbike_pk
        primary key
        constraint twinbike_bike_id_fk
        references "ecoBikeSystem"."Bike"
        on update cascade on delete cascade
);
```

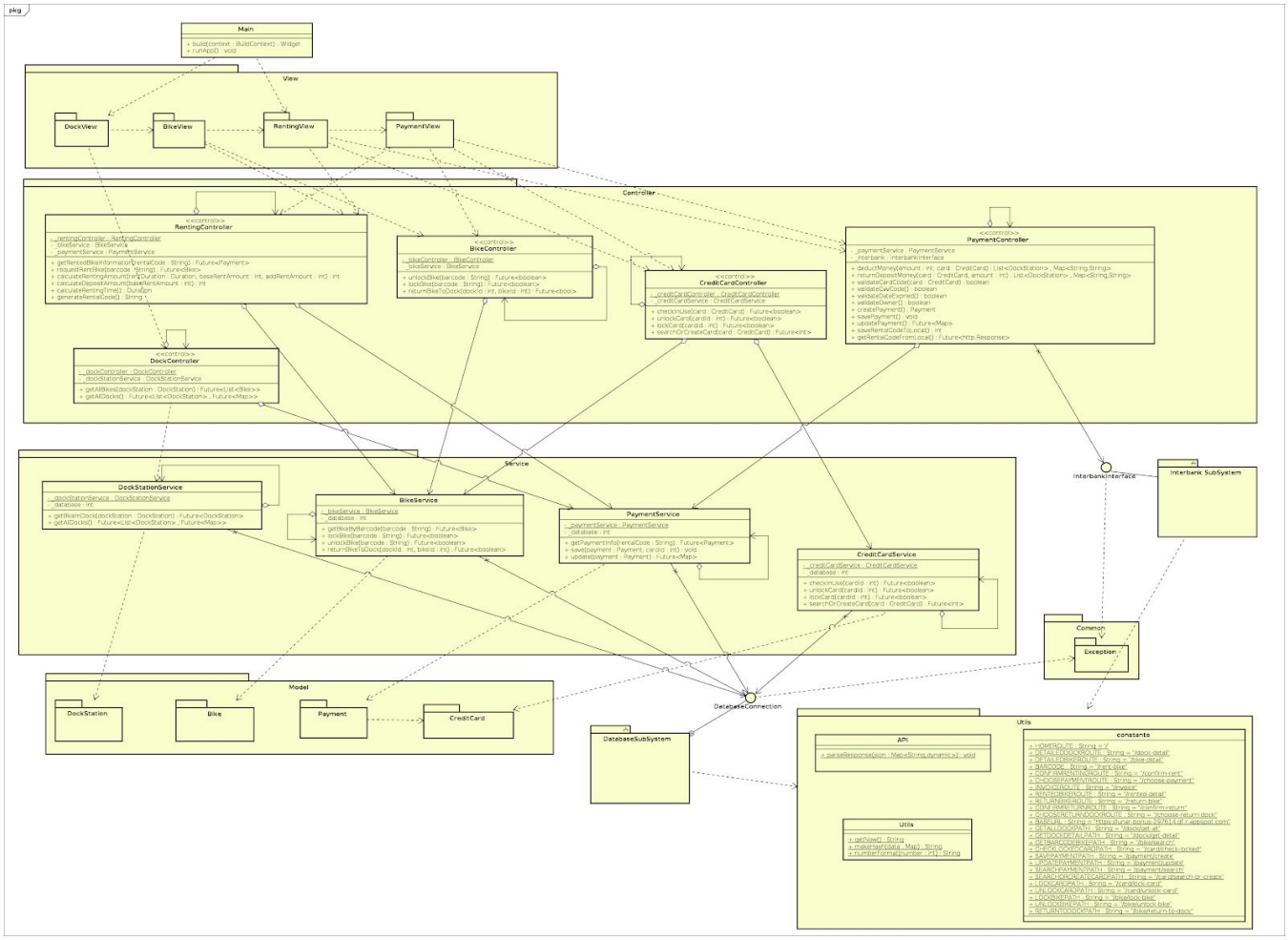
4.3 Non-Database Management System Files

<Provide the detailed description of all non-DBMS files if any and include a narrative description of the usage of each file that identifies if the file is used for input, output, or both, and if the file is a temporary file. Also provide an indication of which modules read and write the file and include file structures (refer to the data dictionary). As appropriate, the file structure information should include the following:

- *Record structures, record keys or indexes, and data elements referenced within the records*
- *Record length (fixed or maximum variable length) and blocking factors*
- *Access method (e.g., index sequential, virtual sequential, random access, etc.)*
- *Estimate of the file size or volume of data within the file, including overhead resulting from file access methods*
- *Definition of the update frequency of the file (If the file is part of an online transaction-based system, provide the estimated number of transactions per unit of time, and the statistical mean, mode, and distribution of those transactions.)*
- *Backup and recovery specifications>*

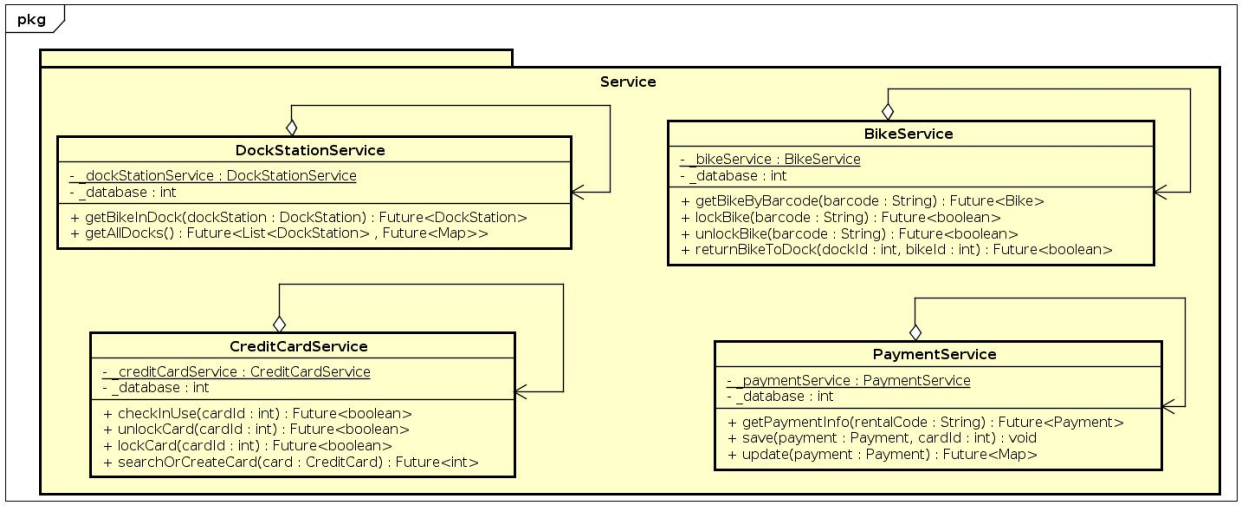
4.4 Class Design

4.4.1 General Class Diagram

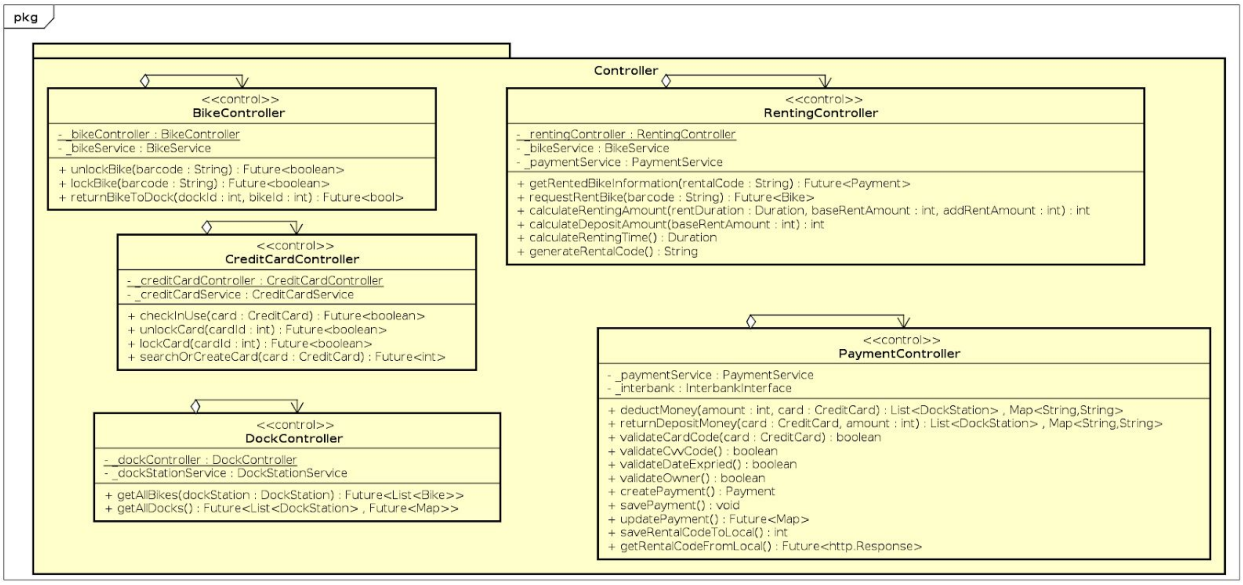


4.4.2 Class Diagrams

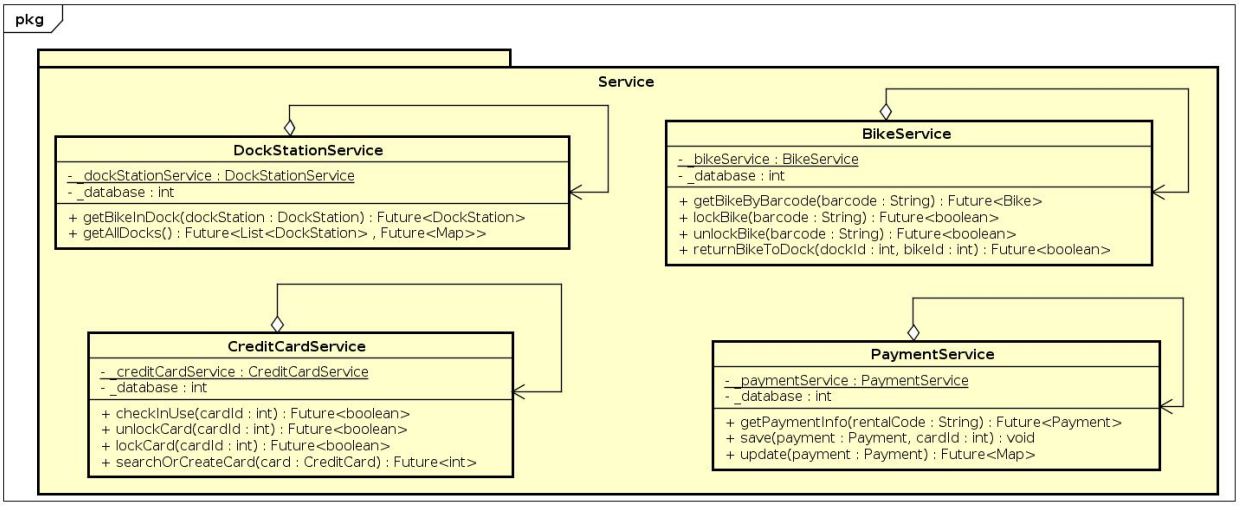
4.4.2.1 Class Diagram for Package View



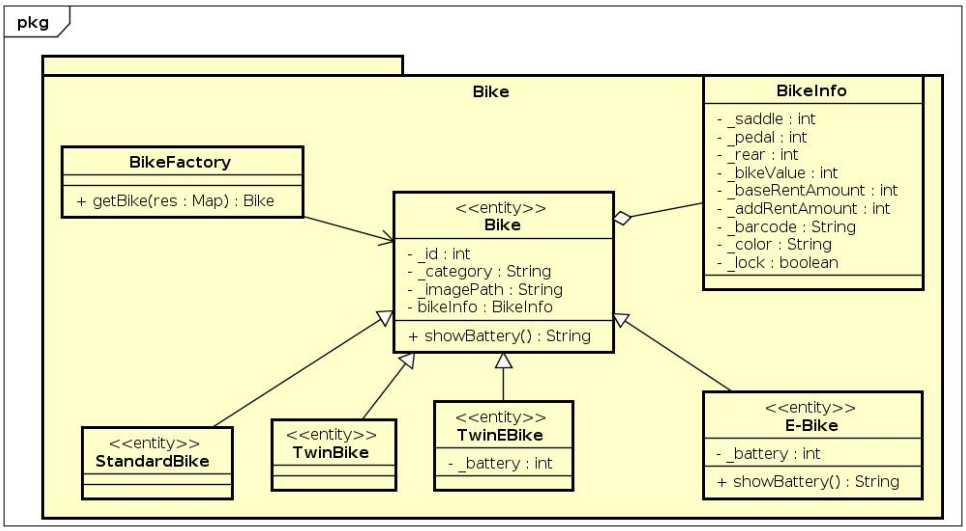
4.4.2.2 Class Diagram for Package Controller

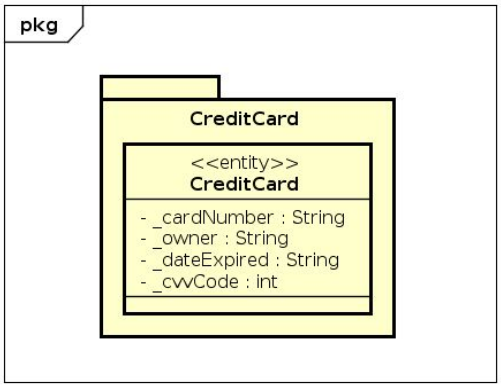


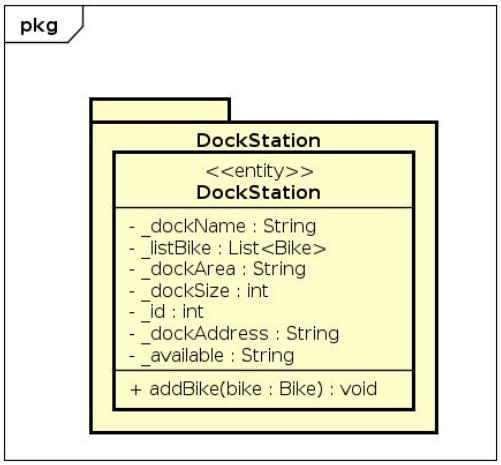
4.4.2.3 Class Diagram for Package Service

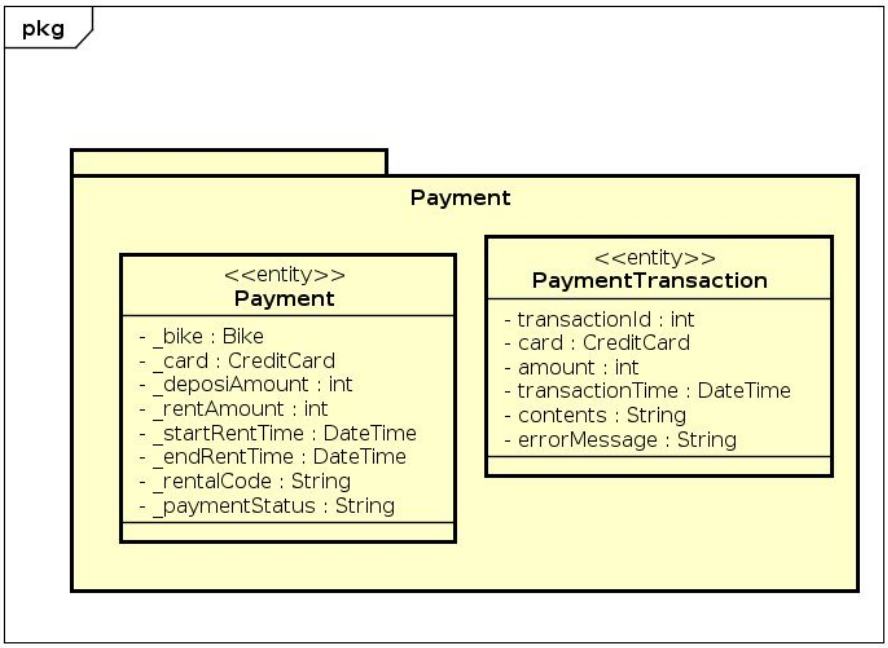


4.4.2.4 Class Diagram for Package Model

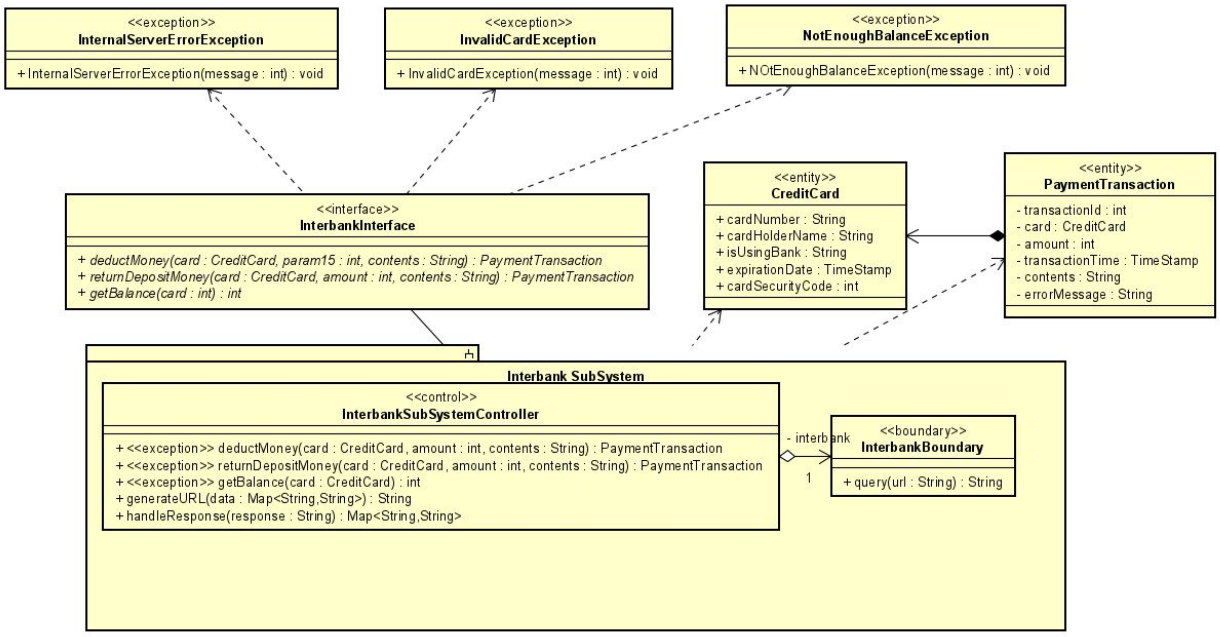

pkg
Bike
BikeInfo
- _saddle : int
- _pedal : int
- _rear : int
- _bikeValue : int
- _baseRentAmount : int
- _addRentAmount : int
- _barcode : String
- _color : String
- _lock : boolean
BikeFactory
+ getBike(res : Map) : Bike
<<entity>>
Bike
- _id : int
- _category : String
- _imagePath : String
- bikeInfo : BikeInfo
+ showBattery() : String
<<entity>>
StandardBike
<<entity>>
TwinBike
<<entity>>
TwinEBike
- _battery : int
<<entity>>
E-Bike
- _battery : int
+ showBattery() : String


pkg
CreditCard
<<entity>>
CreditCard
- _cardNumber : String
- _owner : String
- _dateExpired : String
- _cvvCode : int

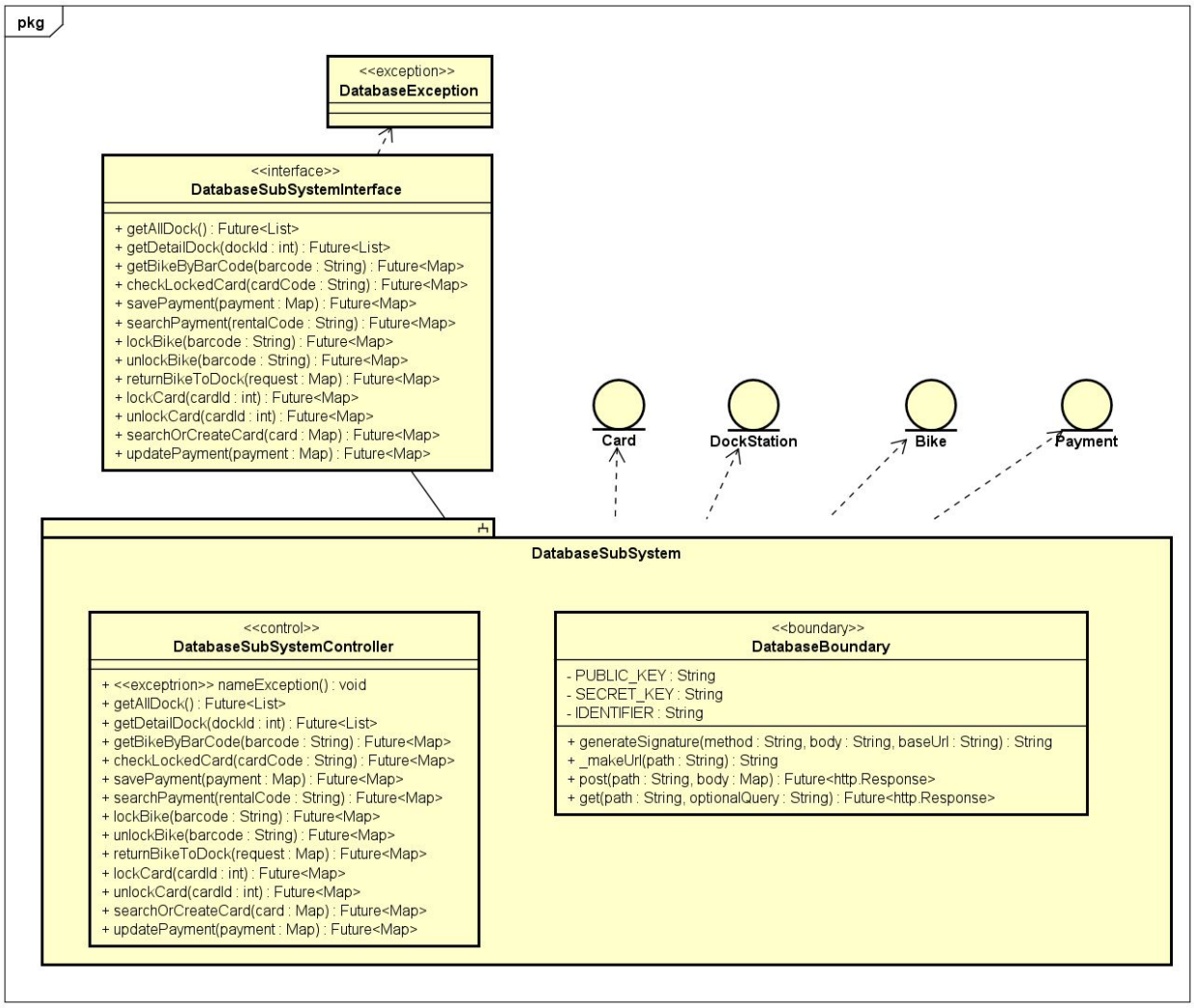

pkg
DockStation
<<entity>>
DockStation
- _dockName : String
- _listBike : List<Bike>
- _dockArea : String
- _dockSize : int
- _id : int
- _dockAddress : String
- _available : String
+ addBike(bike : Bike) : void


pkg
Payment
<<entity>>
Payment
- _bike : Bike
- _card : CreditCard
- _deposiAmount : int
- _rentAmount : int
- _startRentTime : DateTime
- _endRentTime : DateTime
- _rentalCode : String
- _paymentStatus : String
<<entity>>
PaymentTransaction
- transactionId : int
- card : CreditCard
- amount : int
- transactionTime : DateTime
- contents : String
- errorMessage : String

4.4.2.5 Class Diagram for SubSystem Interbank



4.4.2.4 Class diagram for Database Subsystem



4.4.3 Class Design

- Class diagram for package View
- All the class in this view package have a function ***build*** to generate UI components following the standard of material design

BikeScreen

RentedBikeScreen

AppBar

BottomBar

Routing

SectionBanner

DetailedDockScreen

ListDockScreen

ChoosePaymentScreen

InvoiceScreen

BarcodeScreen

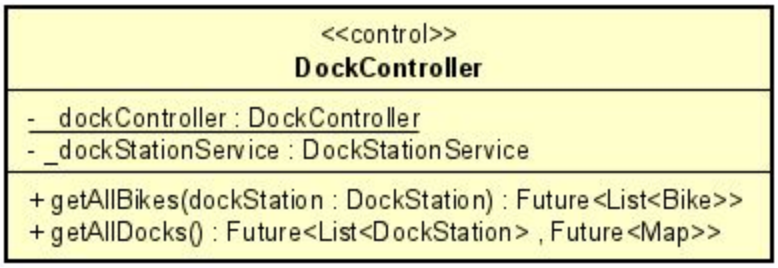
ChooseReturnDockScreen

ConfirmRentedScreen

ConfirmReturnScreen

Class diagram for package Controller

4.4.3.1 Class DockController



Attribute

None

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	getAllBikes	List<Bike>	Get all bikes from a dock station
2	getAllDocks	List<DockStation>	Get all dock station information

Parameter

- DockStation: dockStation - dock station entity

Exception

None

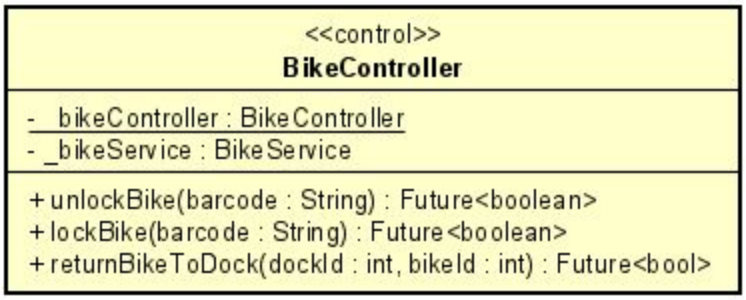
Method

None

State

None

4.4.3.2 Class BikeController



Attribute

None

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	BikeController	factory	Instantiate this object point to this class

2	unlockBike	boolean	unlock bike in dock station
3	lockBike	lock bike	lock bike in dock station
4	returnBikeToDock	boolean	return bike to dock station

Parameter

barcode: String - barcode of bike

dockId: Integer - dock station ID

bikeId: Integer - bike ID

Exception

None

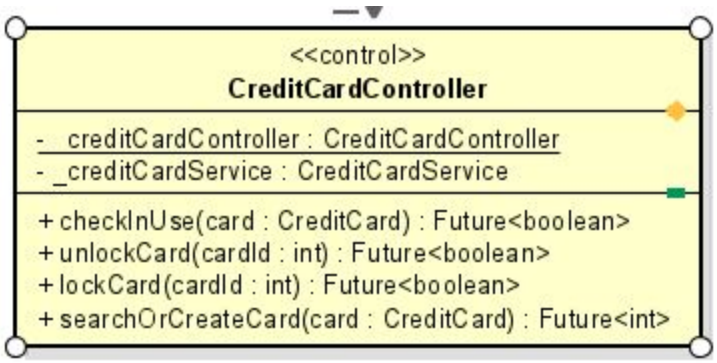
Method

None

State

None

4.4.3.3 Class CreditCardController



Attribute

Operation

#	*Name*	*Return type*	*Description (purpose)*

1	CreditCardController	factory	Instantiate this object point to this class
2	unlockCard	boolean	unlock card
	lockCard	boolean	lock card
3	checkInUse	boolean	check card in use or not
4	searchOrCreateCard	Int	search for card or create if not exist

Parameter:

card: CreditCard
cardId: Integer

Exception:

None

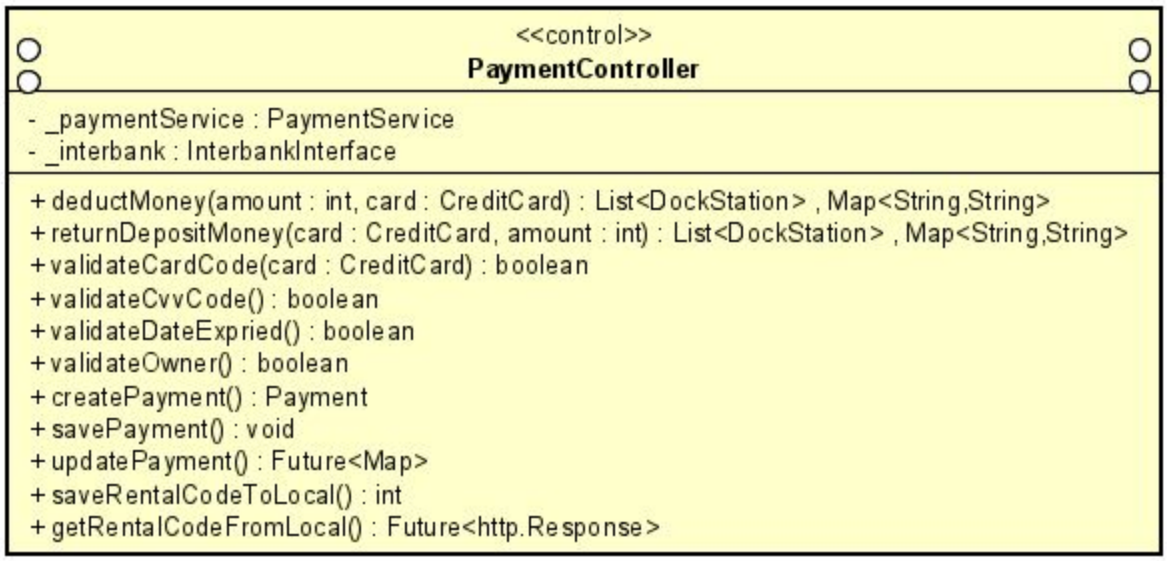
Method

None

State

None

4.4.3.4 Class PaymentController



Attribute

private paymentService: PaymentService

private interbank: InterbankInterface

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	DeductMoney	Map<String,String>	Deduct money for renting and return the result with a message
2	ReturnDepositMoney	Map<String,String>	Return deposit money when user return bike
3	savePayment	Void	Save payment information
4	updatePayment	Map<String,String>	Update payment information

5	saveRentalCodeToLocal	Void	save information of rental code to local memory
6	getRentalCodeFromLocal	String	Get rental code from local

Parameter

rentalCode: rental code of renting

payment: payment entity

cardId: Id of card

bike: bike entity

depositMoney: deposit money

start: starting time of renting

end: ending time of renting

card: card entity

Exception

None

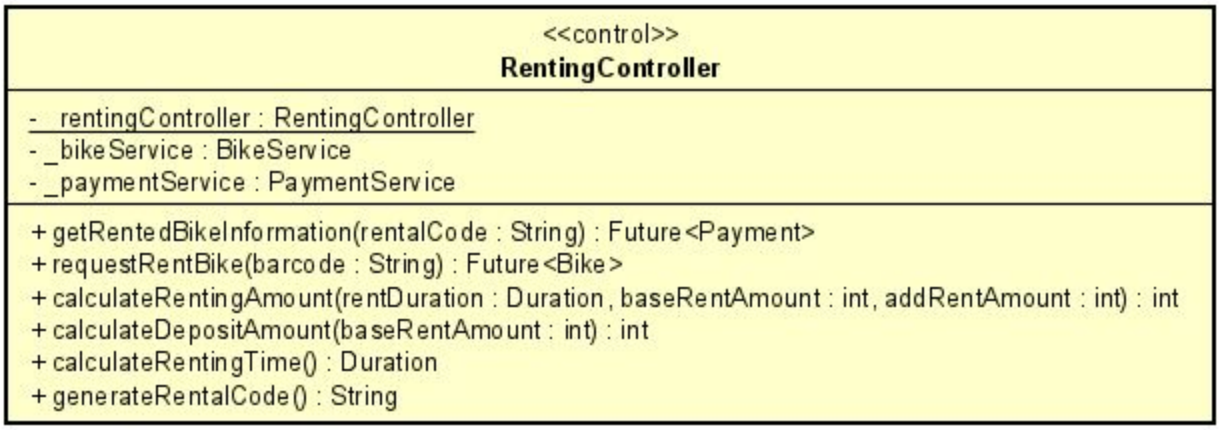
Method

None

State

None

4.4.3.5 Class RentingController



Attribute

private bikeService: BikeService

private paymentService: PaymentService

Operation

#	*Name*	*Return value*	*Description*
1	requestRentBike	Bike	request renting a bike
2	getRentedBikeInformation	Payment	get rented bike information
3	generateRentalCode	String	generate rental code
4	calculate renting amount	Integer	calculate renting amount
5	calculate renting time	Duration	calculate renting time
6	calculate deposit money	int	calculate deposit money

Parameter

barcode: barcode of bike

rentalCode - rental code of renting

rentDuration - duration of renting time

baseRentAmount - base renting amount

addRentAmount - additional renting amount

startTime - starting renting time

endTime - ending renting time

Exception

None

Method

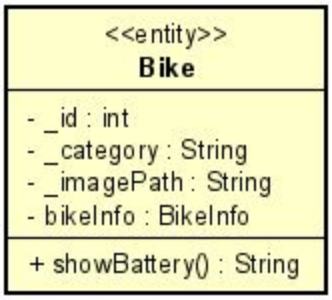
None

State

None

Class diagram for package Model

4.4.3.6 Class Bike



Attribute

private int id - id of bike

private String category - category of bike: Twin, EBike, ...

private String imagePath: path to image: \path\to\image.png

public Bikeinfo bikeInfo: information of bike

Operation

None

Parameter

None

Exception

None

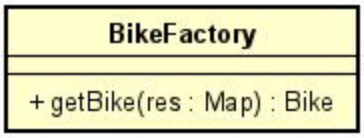
Method

None

State

None

4.4.3.7 Class BikeFactory



Attribute

None

Operation

Bike getBike(res: Map) - Getting an instance of bike

Parameter

None

Exception

None

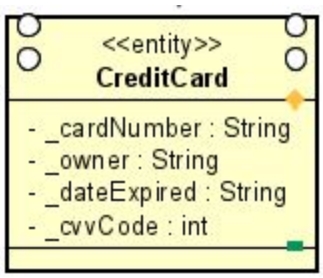
Method

None

State

None

4.4.3.8 Class CreditCard



Attribute

private String cardCode - code of credit card

private String owner - owner's name

private String cvvCode - security code

private String dateExpired - expiration date

Operation

None

Parameter

None

Exception

None

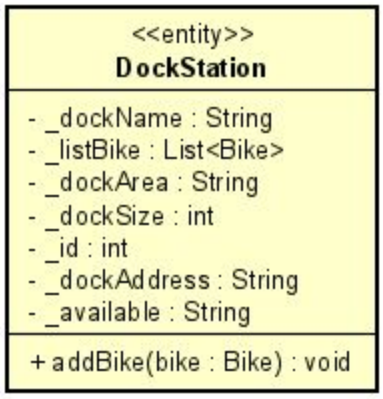
Method:

None

State:

None

4.4.3.9 Class DockStation



Attribute

private int id - id of dock station

private String dockName - dockStation's name

private String dockArea - area of dock station

private String dockAddress - address of dock station

private String available - available bike in dock station

private int dockSize - maximum bike in dock station

private List<Bike> lstBike - list of bike entity in dock station

Operation

None

Parameter

None

Exception

None

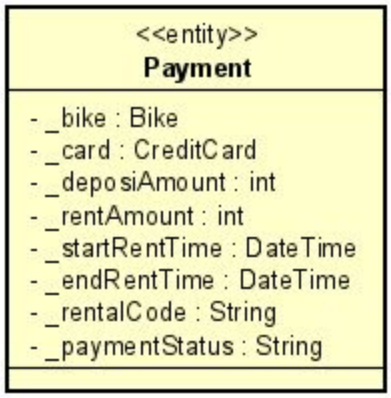
Method

None

State

None

4.4.3.10 Class Payment



Attribute

private Bike bike - bike entity

private CreditCard card - card entity

private int rentAmount - renting Amount

private int depositAmount - deposit amount

private DateTime startRentTime - starting renting time

private DateTime endRentTime - ending renting time

private String paymentStatus - Status of payment

Operation

None

Parameter

None

Exception

None

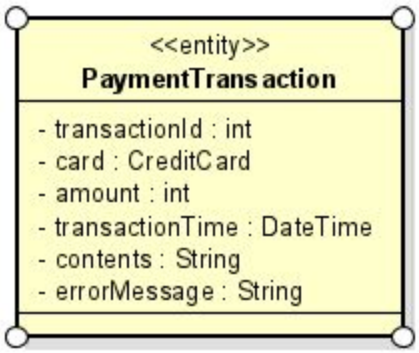
Method

None

State

None

4.4.3.11 Class PaymentTransaction



Attribute

private CreditCard card - card entity

private String command - example: pay, refund, …

private int amount - amount of money

private String createdAt

Operation

None

Parameter

None

Exception

None

Method

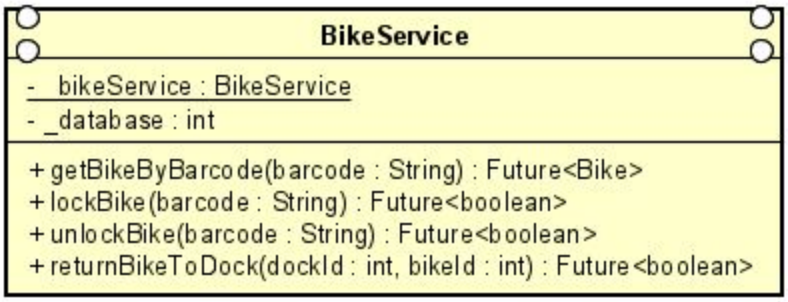
None

State

None

Class diagram for package Service

4.4.3.12 Class BikeService



Attribute

private BikeService bikeService - static instance of BikeService

private DatabaseConnection database - instance of Database connection

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	getBikeByBarcode	Bike	get bike by barcode
2	lockBike	Boolean	lock bike
3	unlockBike	Boolean	unlock bike
4	returnBikeToDock	Boolean	return bike to dock station

Parameter

listDock: List<DockStation> - list of DockStation model

bike:Bike - the bike selected

Exception

rentedBikeException - exception raise if the rented bike is not eligible

paymentException - exception raise if there is no payment with the bike

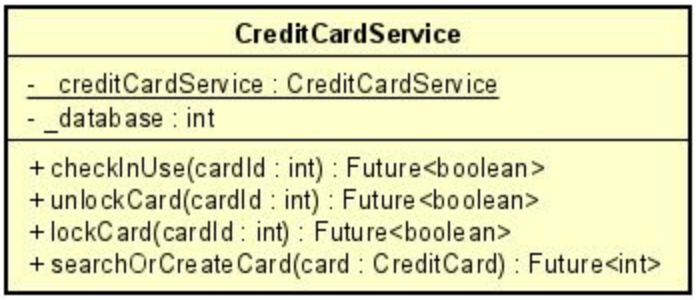
Method

None

State

None

4.4.3.13 Class CreditCardService



Attribute

#	*Name*	*Return type*	*Description (purpose)*
1	creditCardService	CreditCard Service	Static instance of credit card service
2	database	DatabaseC onnection	Instance of database connection

Operation

#	*Name*	*Return type*	*Description (purpose)*

1	checkInUse	boolean	Request all related information for selected bike from database
2	unlockCard	boolean	Change rented bike's lock status
3	lockCard	boolean	lock card by card ID
4	searchOrCreateCard	Integer	search for card or create if not exist

Parameter

card: card entity

cardid: id of card

Exception

None

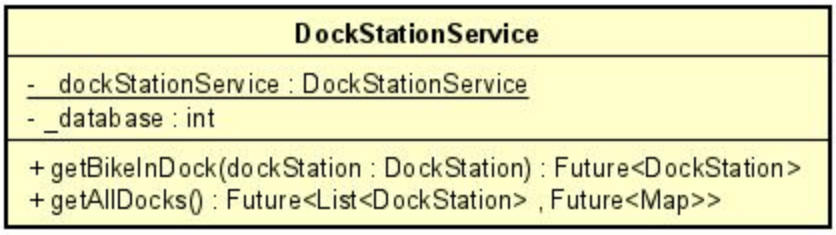
Method

None

State

None

4.4.3.14 Class DockStationsService



Attribute

#	*Name*	*Data type*	*Default value*	*Description*
1	dockStationService	DockStationService	Null	Static variable of dock station service

2	database	DatabaseConnection		

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	getBikeInDock	DockStation	Request selected bike's color
2	getAllDocks	Map<String,String>	Get all dock station

Parameter

dockStation: dock station entity

Exception

None

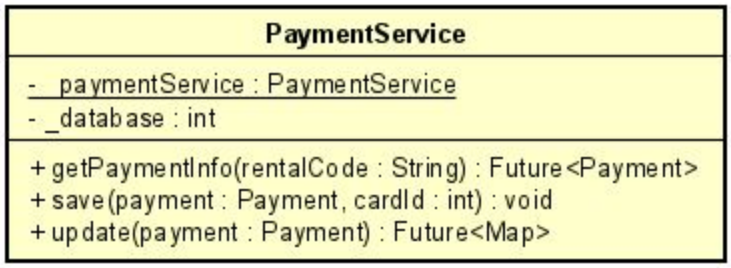
Method

None

State

None

4.4.3.15 Class PaymentService



Attribute

None

Operation

#	*Name*	*Return type*	*Description (purpose)*
1	paymentService	PaymentService	static instance of payment service
2	database	DatabaseConnection	instance of database connection

Parameter

rentalCode: string – the rental code of the rented bike

barcode: string - barcode of the bike

dock: DockStation - dock station model

Exception

None

Method

None

State

None

5 Design Considerations

5.1 Goals and Guidelines

5.1.1 Goals

- Usability: User Interface Easy-to-use
- Speed Optimization for less-than-5-second User Interaction
- Memory Usage Optimization for better app performance

5.1.2 Guidelines

Coding Convention for Flutter-Dart:

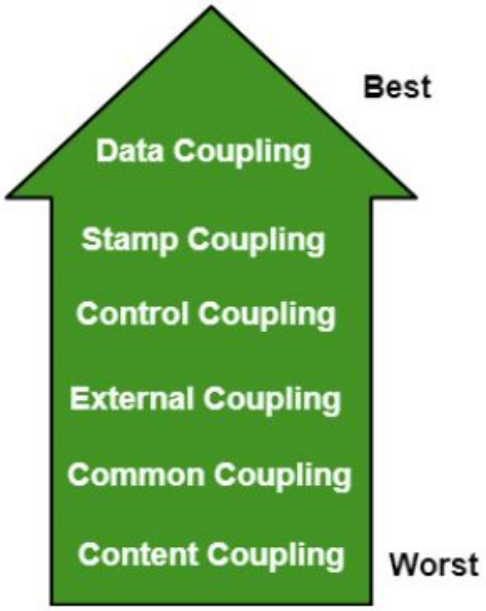
Using Basic Coding Convention of Dart Language. Detailed show at https://dart.dev/guides/language/effective-dart/style

5.2 Architectural Strategies

- *Programming Language: Dart*
- *Framework: Flutter*
- *Database Management System: PostgreSQL*
- *Using Subsystem: Interbank System for Card Management, Database System for Getting Data from Database*
- *Error Detection: Using Unit-test and Integration Test*
- *Synchronization: Asynchronization Method using Dart Language*

5.3 Coupling and Cohesion

Coupling: Coupling is the measure of the degree of interdependence between the modules. A good software will have low coupling



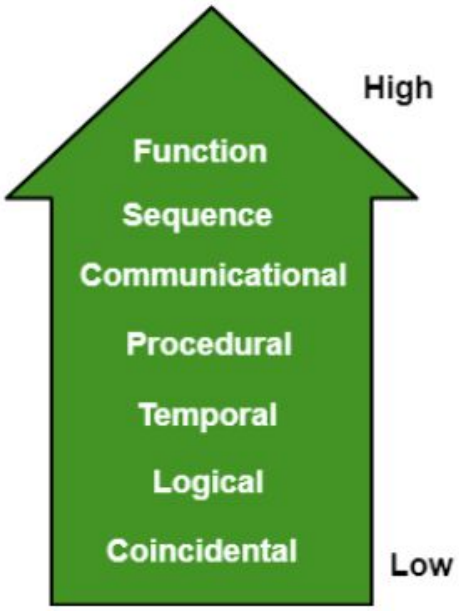
Our Project has both **Data Coupling & Control Coupling**.

- In data coupling, the components are independent to each other and communicating through data. Module communications don't contain tramp data. Example - RentingController class only knows how to get data from Bike Entity class and use it for a totally different method to take it to the View package.

- In Control coupling, the modules communicate by passing control information, then they are said to be control coupled. It can be bad if parameters indicate

completely different behavior and good if parameters allow factoring and reuse of functionality. Example - In class BikeFactory, we pass the parameter “category” string to know which category will be taken, then return the responding child class Ebike or Standardbike,.....

Cohesion: Cohesion is a measure of the degree to which the elements of the module are functionally related. It is the degree to which all elements directed towards performing a single task are contained in the component. Basically, cohesion is the internal glue that keeps the module together. A good software design will have high cohesion



Our Project Use **Functional Cohesion.** Every essential element for a single computation is contained in the component. A functional cohesion performs the task and functions. For example, calculateRentingAmount method in RentingController class performs the calculation task and sends it to RentedBikeView. The RentedBikeView class only renders the returned value.

5.4 Design Principles

SOLID principles are the design principles that enable us to manage most of the software design problems.

SOLID Acronym:

- S: Single Responsibility Principle (SRP)
- O: Open closed Principle (OSP)

- L: Liskov substitution Principle (LSP)
- I: Interface Segregation Principle (ISP)
- D: Dependency Inversion Principle (DIP)

1.1 Single Responsibility Principle

“ A class should have only one reason to change”. Every module or class should have responsibility over a single part of the functionality provided by the software and that responsibility should be entirely encapsulated by the class.

1.2 Liskov Substitution Principle

“Objects in a program should be replaceable with instances of their subtypes without altering the correctness of that program”. If a program module is using a Base class, then the reference to the Base class can be replaced with a Derived class without affecting the functionality of the program module. We can also state that Derived types must be substitutable for their base types.

1.3 Open/Closed Principle

“Software entities should be open for extension, but closed for modification”. The design and writing of the code should be done in a way that new functionality should be added with minimum changes in the existing code. The design should be done in a way to allow the adding of new functionality as new classes, keeping as much as possible existing code unchanged.

1.4 Interface Segregation Principle

“Many client-specific interfaces are better than one general-purpose interface”. We should not enforce clients to implement interfaces that they don't use. Instead of creating one big interface we can break down it to smaller interfaces

1.5 Dependency Inversion Principle

One should “depend upon abstractions, [not] concretions" . Abstractions should not depend on the details whereas the details should depend on abstractions. High-level modules should not depend on low level modules.

5.5 Design Patterns

5.5.1 Singleton

Singleton pattern is one of the simplest design patterns in OOP Language. This type of design pattern comes under the creational pattern as this pattern provides one of the best ways to create an object.

This pattern involves a single class which is responsible to create an object while

making sure that only a single object gets created. This class provides a way to access its

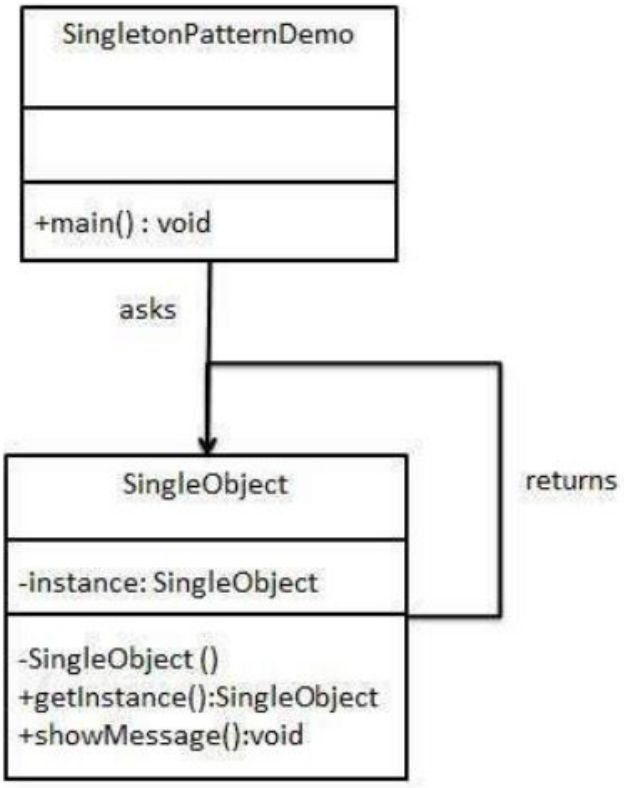
only object which can be accessed directly without need to instantiate the object of the

class.

SingleObject class provides a static method to get its static instance to outside

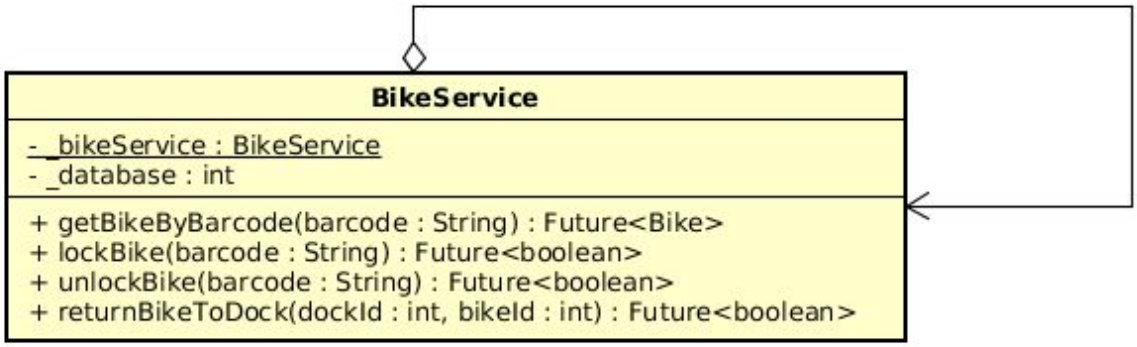
world. SingletonPatternDemo, our demo class will use SingleObject class to get a

SingleObject object.



In our EcoBikeRental System, we use many Singleton classes, such as class DBConnection() for getting the instance for getting data from database, or some service class for initiating business logic for getting databases and assigning to a model.

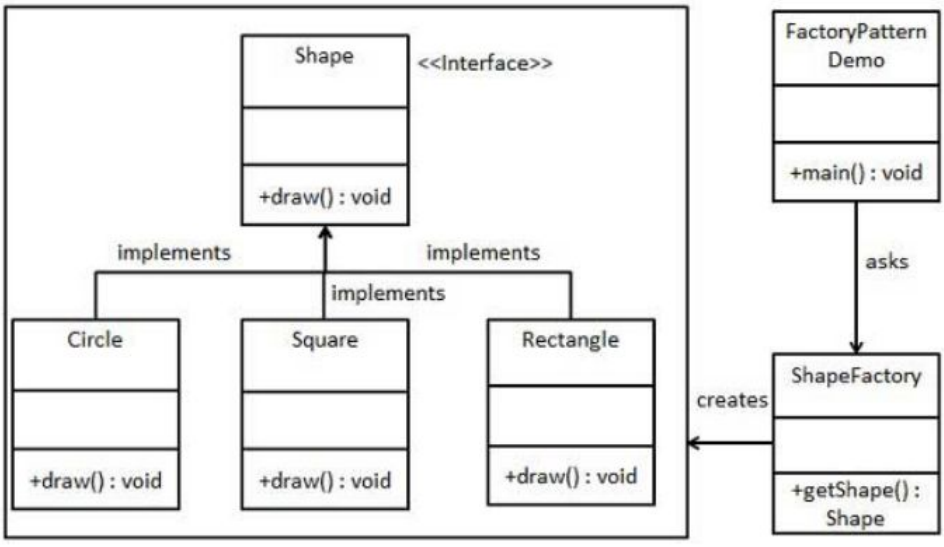
Example:



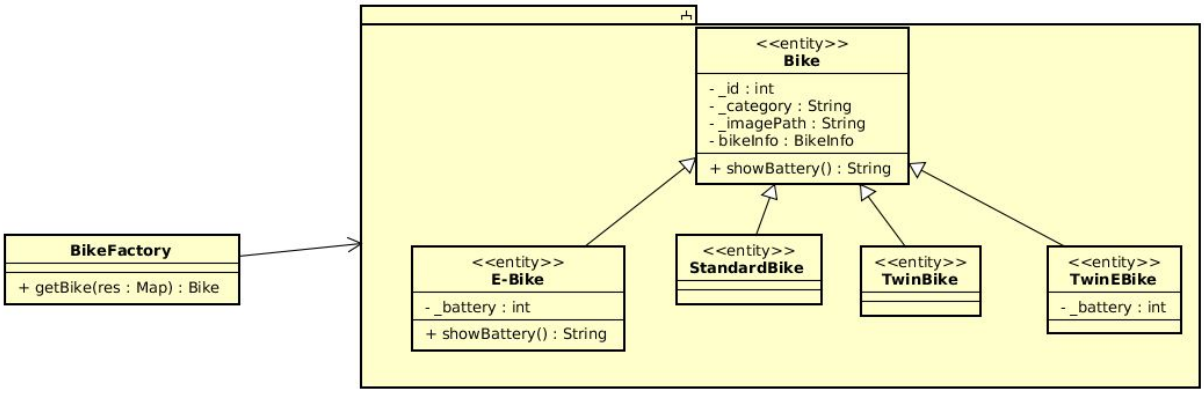
5.5.2 Factory Pattern

Factory pattern is one of the most used design patterns. This type of design pattern comes under creational pattern as this pattern provides one of the best ways to create an object.

In Factory pattern, we create objects without exposing the creation logic to the client and refer to newly created objects using a common interface.



Example:



Here, Our BikeFactory class uses getBike() static class to get instances from different Bike Implementation from the “category” string obtained from the database.

5.5.3 MVC

In our EcoBikeRental System, we also use MVC Pattern as our main Design Pattern Structure. Our general MVC Design Pattern will follow as the below picture: