UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

Dipartimento di Ingegneria Elettrica e Tecnologie dell'Informazione

Corso di Laurea in Informatica

Software Engineering I Project
GCI '16

Customer:

Sergio Di Martino

Team:

GCI16_25

Carlo De Vita N86001634

Mattia Iodice N86001672

Riccardo Grieco N86001614

Table of contents

1 Introduction

1.1 Subject

This document represents the documentation with requirements collection, design and testing of the software product GCI ‘16, the analysis is based on a functionality subset selected by the costumer, Sergio Di Martino. In particular we have developed these points: 3, 4 and 6. For more details we have reported the specifications of the product as taken from “Progetto-16-17_V03F” document, published by the customer below.

SoftEngUniNA Protocollo N.:

3. Specifiche di prodotto/ servizio

Il ***GCI16*** (Gestione Canoni Idrici) è un Sistema Informativo di una Pubblica Amministrazione Locale, finalizzato a gestire il pagamento di una tassa per il consumo di acqua. Il sistema distribuito presenta una parte di Back-Office per la gestione di contribuenti, ingiunzioni e pagamenti, ed un client su dispositivo mobile, utilizzato dai Controllori per leggere i consumi di acqua presso i contatori.

I principali servizi offerti dal sistema sono i seguenti:

1. Gestione Anagrafica Contribuenti.
2. Generazione Bollette.
3. Gestione Ingiunzioni di Pagamento.
4. Emissione Ingiunzioni di Pagamento.
5. Amministrazione Sistema
6. Lettura Consumi

Gli operatori del sistema, opportunamente autenticati, devono avere la possibilità di effettuare le tipiche operazioni CRUD sulla base di dati contenente l’anagrafica dei contribuenti. Gli operatori possono, ogni trimestre, chiedere la generazione delle bollette per tutte le utenze. Gli operatori possono inoltre creare nuove ingiunzioni di pagamento, specificando una persona fisica o giuridica che risulta essere evasore, un anno di competenza e inserendo le letture prese dai tecnici per il contatore corrispondente. Il sistema, basandosi su alcuni parametri configurabili, deriva l'ammontare dovuto. Un'ingiunzione può essere modificata ed eliminata solo se non emessa, previa opportuna ricerca.

Per emettere un’ingiunzione di pagamento, un operatore del Back-Office può selezionarne una da una lista di ingiunzioni non ancora emesse e, previo inserimento di un numero di protocollo, procedere con l'emissione. Ciò deve generare un documento in formato PDF contenente le comunicazioni che saranno inviate ai contribuenti.

Le ingiunzioni emesse non possono più essere cancellate, ma solo aggiornate. In presenza del relativo pagamento, l’ingiunzione viene archiviata. In presenza di un’opposizione, l’ingiunzione viene sospesa.

Inoltre è possibile effettuare il re-inserimento e quindi la riemissione di quelle ingiunzioni che non è stato possibile notificare (ad esempio per indirizzo errato).

Un amministratore di sistema deve inoltre poter gestire gli operatori, specificare l'ammontare delle spese di spedizione, delle tariffe per metro cubo e la percentuale di IVA da applicare. Infine, gli addetti alla lettura dei consumi utilizzano un dispositivo mobile per specificare, ogni 3 mesi, i consumi d'acqua di un utente, così come rilevabile dai contatori. Il dispositivo invia la lettura al server in modalità wireless.

Le funzionalità da 1 a 4 sono disponibili sul Back-Office ad un operatore opportunamente identificato dal sistema.

La funzionalità 5 è disponibile in forma di App sul client mobile dato in dotazione agli Operatori sul Campo.

Dato questo insieme di funzionalità, il Committente deciderà insieme al fornitore un sottoinsieme di caratteristiche da modellare e implementare, previo incontro formale secondo le modalità specificate sul sito web.

SoftEngUniNA Protocollo N.:

Per lo svolgimento della suddetta attività è obbligatorio l'utilizzo di un tool di CASE.

Si richiede tassativamente di astrarre il design per favorire il riutilizzo del codice e la futura implementazione di altre funzionalità.

Nota: Tutte le attività devono essere effettuate presso il fornitore tranne per i momenti di condivisione definiti.

1.2 Revision history

Date	Version	Description
07/12/2016	0.1	Created first requirements list (functional, non-functional and domain) and Use Cases.
31/03/2017	0.1.1	Updated the requirements list and created Mockups.
13/04/2017	0.2	Updated Use Cases and Mockups.
29/04/2017	0.3	Created Cockburn diagrams for use cases.
3/05/2017	0.3.1	Added the Glossary and the State chart diagram for payment orders.
10/05/2017	0.3.2	Updated and finished Use case, Mockups and Cockburn diagrams.
25/05/2017	0.4	Added Entity Boundary Control Class Diagram.
11/06/2017	0.4.1	Updated Entity Boundary Control and added Sequence Diagrams.
14/06/2017	0.5	Created System design section.
22/07/2017	0.5.1	Created Object design section with the Object Design Class Diagrams.
26/07/2017	0.5.2	Fixed Object Design Class Diagrams.
27/07/2017	0.5.3	Added technologies and libraries for some functionalities.
30/07/2017	0.5.4	Added CRC Cards and Sequence Diagrams.
7/09/2017	0.6	Updated Sequence Diagrams completing Design section and created Testing section.
22/09/2017	0.6.1	Added System testing plan.
8/10/2017	0.6.2	Added Unit Testing and completed the first version of the documentation.
14/10/2017	1.0	Revision of the entire documentation and completed the first version.

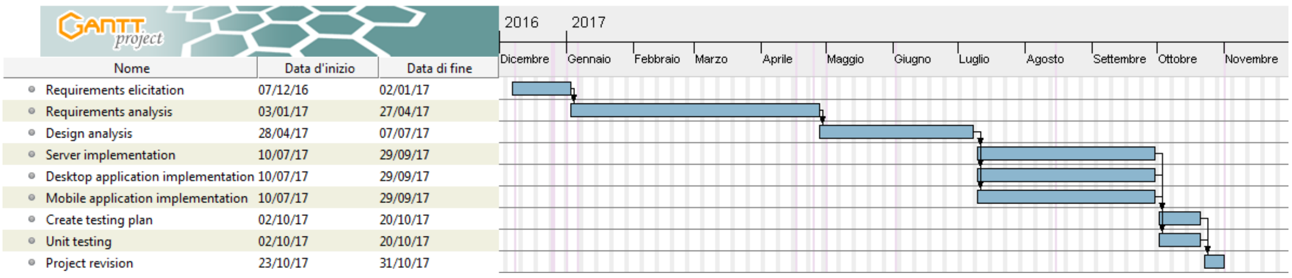
2 Team Organization

2.1 Activity planning

The following diagrams show how the team has decided to organize the teamwork. They have been developed in the early stage of the project and deadlines first decided could not have been really respected.

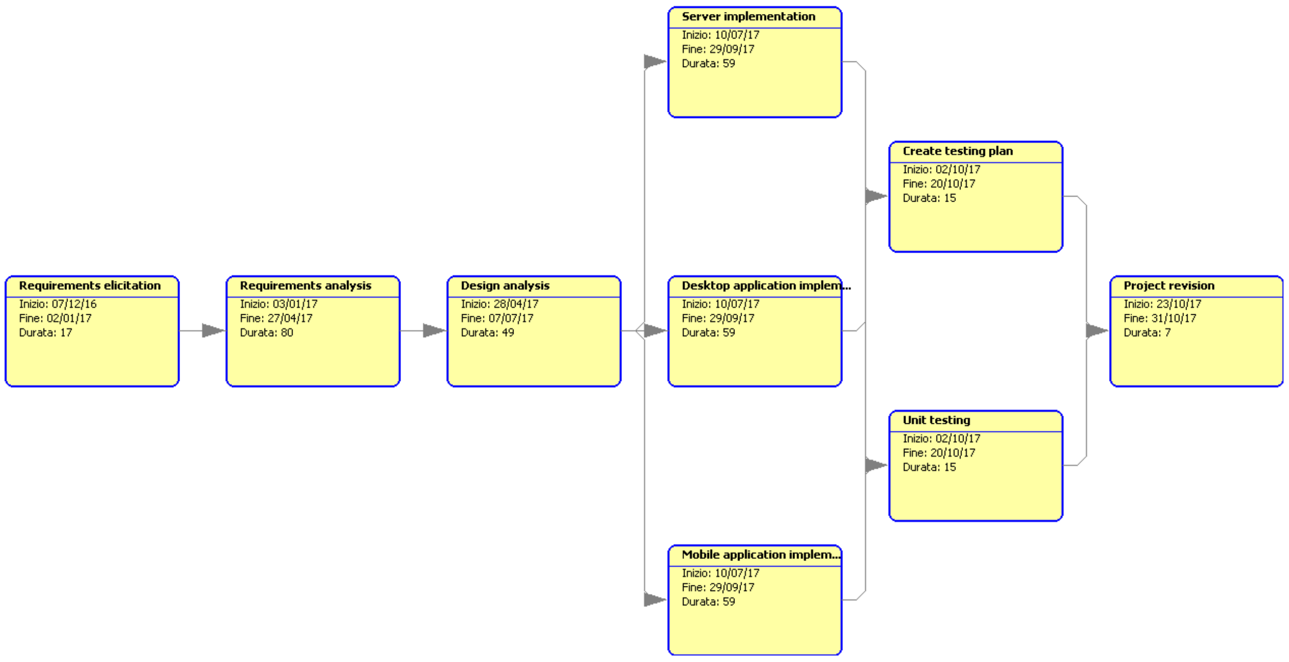
The diagrams have been created using Gantt Project Tool.

2.1.1 Gantt Diagram



Nome	Data d'inizio	Data di fine
Requirements elicitation	07/12/16	02/01/17
Requirements analysis	03/01/17	27/04/17
Design analysis	28/04/17	07/07/17
Server implementation	10/07/17	29/09/17
Desktop application implementation	10/07/17	29/09/17
Mobile application implementation	10/07/17	29/09/17
Create testing plan	02/10/17	20/10/17
Unit testing	02/10/17	20/10/17
Project revision	23/10/17	31/10/17

2.1.2 Pert Diagram



2.2 Resources sharing

The resources are shared using Git version control system, under the hosting platform Github.

The link of the resources is https://github.com/CarloDeVita/INGSW.git

3 Requirements document

3.1 Requirements List

3.1.1 Functional requirements

- The Back-Office Operator must be able to create new payment orders, specifying a bill from a list of candidates.
- The Back-Office Operator can issue not-issued payment orders.
- When a payment order is issued, it is given a protocol number generated incrementally.
- The Back-Office Operator can delete not-issued payment orders.
- The Back-Office Operator can reissue suspended payment orders.
- When a payment order is reissued his protocol number is not changed.
- The Back-Office Operator can save as not pertinent suspended payment orders.
- The Back-Office Operator can save as paid notified payment orders.
- The Back-Office Operator can save as suspended notified payment orders.
- When a payment order is issued the system must generate and store a PDF document with all the useful communications for the debtor.
- A user must be able to log in as a Back-Office Operator in desktop application.
- A user must be able to log in as a Readings Operator in mobile application.
- The Readings Operator can download the list of his assignments from the mobile application.
- The Readings Operator can save readings specifying a meter and the water consumed.
- The Readings Operator must be able to send saved readings via Internet.

3.1.2 Non-functional Requirements

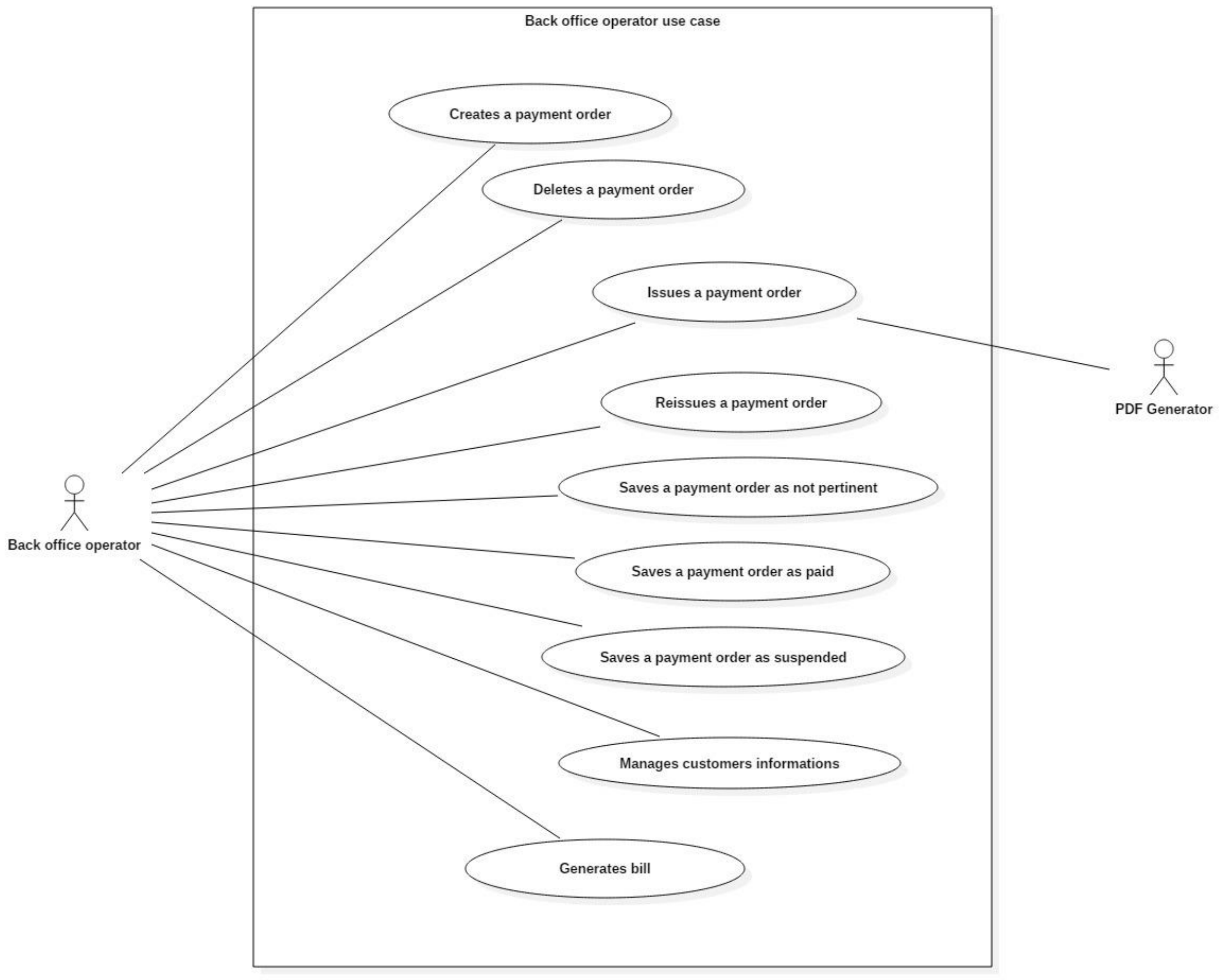
- Payment orders can be seen and searched specifying a protocol, a debtor, a year, a trimester and/or a status.
- The readings are first saved locally on smartphone and sent later only if internet connection is available.
- To use the system every user must log in.

3.1.3 Domain Requirements

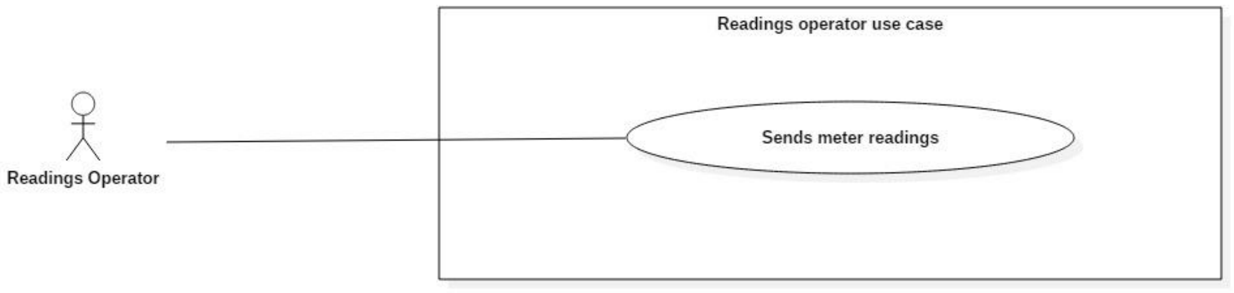
- Not issued payment orders can only be issued or deleted.
- Issued payment orders can only be archived.
- Once saved as paid or saved as not pertinent, a payment order must be archived.
- Suspended payment orders can only be reissued or saved as not pertinent.
- Every issued payment order is identified by a protocol number.
- Notified payment orders can only be saved as paid or as suspended.
- The considered unit of measurement of water consumption is m^3.

3.2 Use Case Diagrams

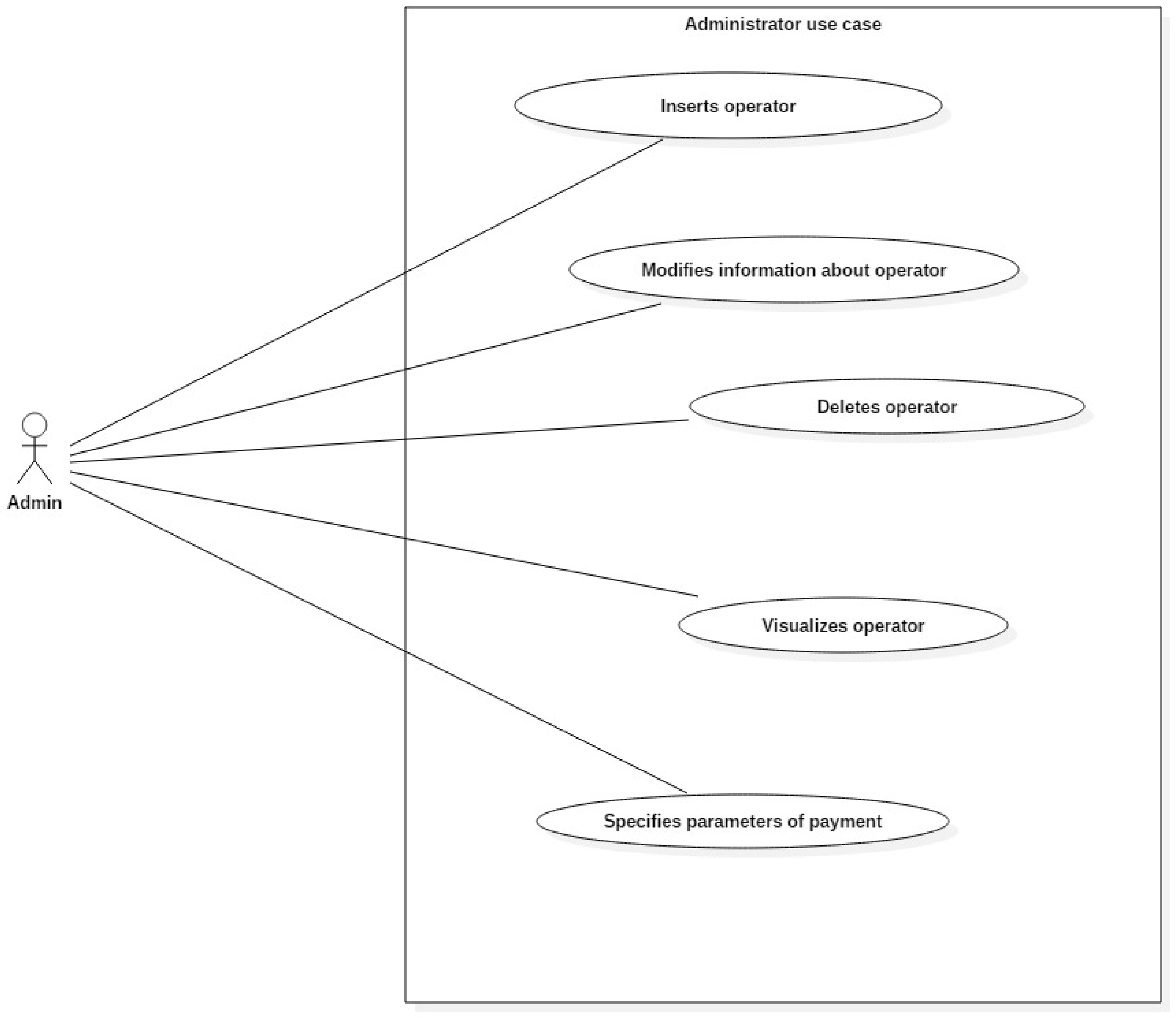
3.2.1 Back office operator use case


Back office operator use case
Creates a payment order
Deletes a payment order
Issues a payment order
Reissues a payment order
Saves a payment order as not pertinent
Saves a payment order as paid
Saves a payment order as suspended
Manages customers informations
Generates bill
Back office operator
PDF Generator

3.2.2 Readings operator use case



3.2.3 Administrator use case



3.3 Cockburn Diagrams for Use Cases

3.3.1 Create payment order

USE CASE #1	*Create payment order*		
Goal in Context	Generate a new payment order.		
Scope & Level	System under design; Level = User goal		
Preconditions	The user must be logged in the system.		
Success End Condition	A payment order is created and stored in the system.		
Failed End Condition	The user presses “Home” in “Payment Orders” mockup.		
Primary Actor	Back Office Operator.		
Trigger	The operator presses “Payment Orders” in “Main Menu” mockup.		
DESCRIPTION	**Step n°**	**Back Office Operator**	**System**
	1		Shows mockup “Payment Orders”
	2	Presses “New payment order”	
	3		Shows mockup “Candidate Payment Orders”
	4	Selects a bill	
	5		Enables “Create Payment Order”
	6	Presses “Create Payment Order”	
	7		Shows mockup “Confirm”
	8	Presses “Yes”	
	9		Shows mockup “Operation Success”

	10	Presses “OK”	
	11		*Returns to mockup “Payment Orders”*
EXTENSIONS	**Step n°**	**Back Office Operator**	**System**
	2.1	Presses “Home”	
	2.2		*Shows mockup “Main Menu”*
SUBVARIATIONS	*Step*	**Back Office Operator**	**System**
	2.2	Sets filtering parameters and presses “Filter”	
	3.2		*Shows the filtered table and return to step #2*

3.3.2 Delete payment order

USE CASE #2	*Delete payment order*		
Goal in Context	Delete a selected payment order.		
Scope & Level	System under design; Level = User goal		
Preconditions	The user must be logged in the system.		
Success End Condition	A payment order is deleted from the system.		
Failed End Condition	The user presses “Home” in “Payment Orders” mockup.		
Primary Actor	Back Office Operator.		
Trigger	The operator presses “Payment Orders” in “Main Menu” mockup.		
DESCRIPTION	**Step n°**	**Back Office Operator**	**System**
	1		Shows mockup “Payment Orders”
	2	Selects a payment order	
	3		Enables “Delete”
	4	Presses “Delete”	
	5		Shows mockup “Confirm”
	6	Presses “Yes”	

	7		Shows mockup “Operation Success”
	10	Presses “OK”	
	11		*Returns to mockup “Payment Orders”*
EXTENSIONS	**Step n°**	**Back Office Operator**	**System**
	2.1	Presses “Home”	
	3.1		*Shows mockup “Main Menu”*
SUBVARIATIONS	*Step*	**Back Office Operator**	**System**
	2.2	Sets filtering parameters and presses “Filter”	
	3.2		*Shows the filtered table and return to step #2*

3.3.3 Issue payment order

USE CASE *#3*	Issue payment orders.		
Goal in Context	User issues a payment order.		
Scope & Level	System Under Design; Level = “User goal”		
Preconditions	User must be logged.		
Success End Condition	A payment order is issued.		
Failed End Condition	User presses ‘Home’ in mockup ‘Payment Orders’.		
Primary Actor	Back office operator.		
Trigger	Back office operator presses ‘Payment Orders’ in mockup ‘Main menu’.		
DESCRIPTION	**Step n°**	**Back Office Operator**	**System**
	1	Presses ‘Payment Orders’ in mockup ‘Main’.	
	2		Shows mockup ‘Payment Orders’.
	3	Selects a not issued payment order.	
	4		Enables button ‘Issue’.
	5	Presses ‘Issue’.	
	6		Shows mockup ‘Confirm’.
	7	Presses ‘Yes’.	
	8		Shows mockup ‘Successful operation’.
	9	Presses ‘Ok’.	

	10		Shows mockup ‘Payment Orders’ in which the payment order concerned shall be issued, and UC successfully ends.
EXTENSIONS	***Step***	**Back Office Operator**	**System**
	**.1*	Presses ‘Home’ in mockup ‘Payment Orders’.	
	**2.1*		Shows mockup ‘Main’ and UC fails.
	5.2	Presses ‘No.	
	6.2		Back to step 2.
SUBVARIATIONS	***Step***	**Back Office Operator**	**System**
	3.3	Filters a not issued payment order, selects.	
	4.3		Back to step 4.

3.3.4 Save as not pertinent payment order

USE CASE *#4*	Save as not pertinent payment orders.
Goal in Context	User saves as not pertinent a suspended payment order.
Scope & Level	System Under Design; Level = “User goal”
Preconditions	User must be logged.
Success End Condition	A payment order is saved as not pertinent.
Failed End Condition	User presses ‘Home’ in mockup ‘Payment Orders’.
Primary Actor	Back office operator.
Trigger	Back office operator presses ‘Payment Orders’ in mockup ‘Main menu’.

DESCRIPTION	**Step n°**	**Back Office Operator**	**System**
	1	Presses ‘Payment Orders’ in mockup ‘Main menu’.	
	2		Shows mockup ‘Payment Orders’.
	3	Selects a suspended payment order.	
	4		Enables button ‘Save as not pertinent’.
	5	Presses ‘Save as not pertinent’.	
	6		Shows mockup ‘Confirm’.
	7	Presses ‘Yes’.	
	8		Shows mockup ‘Successful operation’.
	9	Presses ‘Ok’.	

	10		Shows mockup ‘Payment Orders’ in which there isn’t the payment order concerned because it shall be saved as not pertinent, and UC successfully ends.
EXTENSIONS	***Step***	**Back Office Operator**	**System**
	**.1*	Presses ‘Home’ in mockup ‘Payment Orders’.	
	**2.1*		Shows mockup ‘Main menu’ and UC fails.
	5.2	Presses ‘No.	
	6.2		Back to step 2.
SUBVARIATIONS	***Step***	**Back Office Operator**	**System**
	3.3	Filters suspended payment order, selects it.	
	4.3		Back to step 4.

3.3.5 Reissue payment order

USE CASE *#5*	Reissue payment orders.		
Goal in Context	User reissues a suspended payment order.		
Scope & Level	System Under Design; Level = “User goal”		
Preconditions	User must be logged.		
Success End Condition	A payment order is reissued.		
Failed End Condition	User presses ‘Home’ in mockup ‘Payment Orders’.		
Primary Actor	Back office operator.		
Trigger	Back office operator presses ‘Payment Orders’ in mockup ‘Main menu’.		
DESCRIPTION	**Step n°**	**Back Office Operator**	**System**
	1	Presses ‘Payment Orders’ in mockup ‘Main menu’.	
	2		Shows mockup ‘Payment Orders’.
	3	Selects a suspended payment order.	
	4		Enables button ‘Reissue’.
	5	Presses ‘Reissue’.	
	6		Shows mockup ‘Confirm’.
	7	Presses ‘Yes’.	
	8		Shows mockup ‘Successful operation’.
	9	Presses ‘Ok’.	

	10		Shows mockup ‘Payment Orders’ in which the payment order concerned shall be issued, and UC successfully ends.
EXTENSIONS	***Step***	**Back Office Operator**	**System**
	**.1*	Presses ‘Home’ in mockup ‘Payment Orders’.	
	**2.1*		Shows mockup ‘Main menu’ and UC fails.
	5.2	Presses ‘No.	
	6.2		Back to step 2.
SUBVARIATIONS	***Step***	**Back Office Operator**	**System**
	3.3	Filters suspended payment order, selects it.	
	4.3		Back to step 4.

3.3.6 Saves payment order as paid

USE CASE *#6*	*Saves payment order as paid*		
Goal in Context	Saving a payment order as paid		
Scope & Level	System under design; Level = User goal		
Preconditions	User must be logged in.		
Success End Condition	The payment order is saved in the system as paid.		
Failed End Condition	There is no payment order that can be saved as paid. The user interrupts the use case.		
Primary Actor	Back Office Operator.		
Trigger	The operator presses button “Payment Order” in “Main Menu” mockup.		
DESCRIPTION	**Step n°**	**Back Office Operator**	**System**
	1		Shows mockup “Payment Orders”
	2	Selects a “notified” payment order from the table and presses “Save as paid” button	
	3		Shows mockup “Confirm”
	4	Presses OK	
	5		Shows mockup “Operation Success”
	6	Presses OK	
	7		*Returns to mockup “Payment Orders”*

EXTENSIONS	**Step n°**	**Back Office Operator**	**System**
	2a	Presses “Home”	
	3a		*Shows mockup “Main Menu”*
SUBVARIATIONS	***Step n°***	**Back Office Operator**	**System**
	2b	Sets filtering parameters and presses “Filter”	
	3b		*Shows the filtered table and return to step #2*

3.3.7 Saves a payment order as suspended

USE CASE #7	*Saves a payment order as suspended.*		
Goal in Context	Saving a payment order as suspended.		
Scope & Level	System under design; Level = User goal.		
Preconditions	User must be logged in.		
Success End Condition	The payment order is saved in the system as suspended.		
Failed End Condition	There is no payment order that can be saved as suspended. The user interrupts the use case.		
Primary Actor	Back Office Operator.		
Trigger	The operator presses button “Payment Order” in “Main Menu”.		
DESCRIPTION	**Step n°**	**Back Office Operator**	**System**
	1		Shows mockup “Payment Orders”
	2	Selects a “notified” payment order from the table and presses “Save as suspended” button	
	3		Shows mockup “Confirm”
	4	Presses OK	
	5		Shows mockup “Operation Success”
	6	Presses OK	
	7		*Returns to mockup “Payment Order”*

EXTENSIONS	**Step n°**	**Back Office Operator**	**System**
	2a	Presses “Home”	
	3a		*Shows mockup “Main Menu”*
SUBVARIATIONS	***Step n°***	**Back Office Operator**	**System**
	2b	Sets filtering parameters and presses “Filter” button	
	3b		*Shows the filtered table and return to step #2*

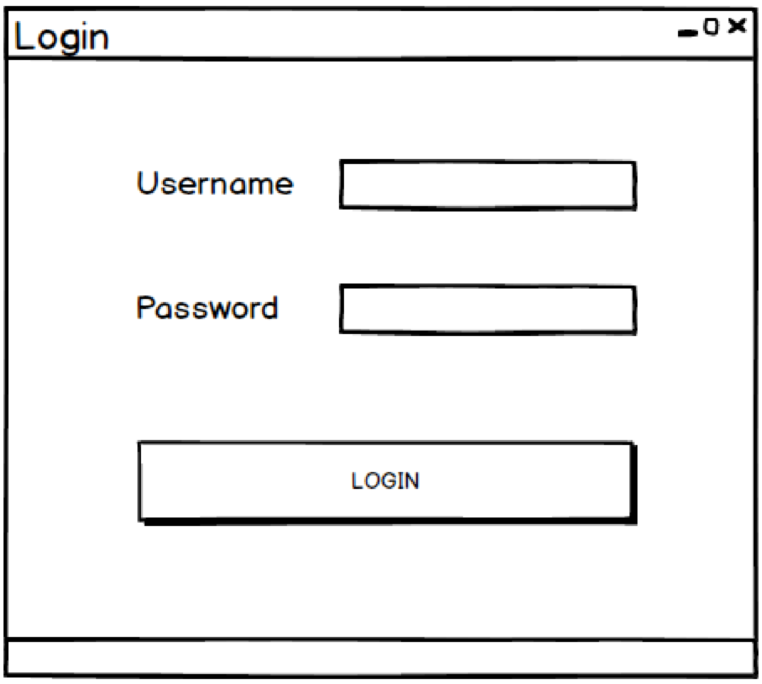
3.3.8 Sends meter readings

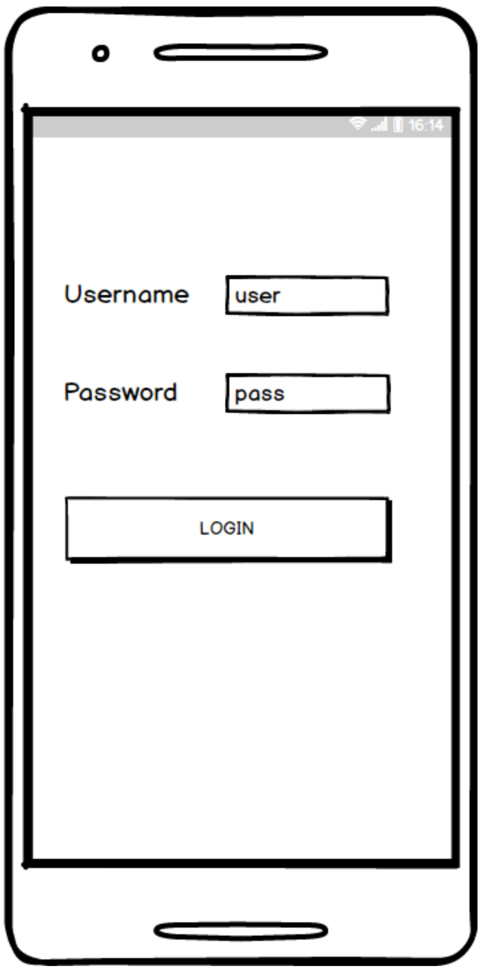
USE CASE *#8*	*Sends meter readings.*		
Goal in Context	Reading the water consumption of a customer.		
Scope & Level	System under design; Level = User goal		
Preconditions	User must be logged in.		
Success End Condition	The Reading Operator saves the water consumption and sends it to the server.		
Failed End Condition	The Readings Operator closes the application. The Readings Operator doesn’t have readings left to do. There is no Internet connection to send the readings done.		
Primary Actor	Readings Operator		
Trigger	User logs in the mobile app.		
DESCRIPTION	**Step n°**	**Readings Operator**	**System**
	1		Shows mockup “Readings Main”
	2	Selects a customer from the list and clicks “Save reading” button	
	3		Shows mockup “Save Reading”
	4	Inserts the amount of water consumed and presses “Save” button	
	5		Shows mockup “Confirm Reading” containing all the reading’s information
	6	Presses “Yes” button	
	7		*Returns to mockup “Readings Main”*
	8	Presses “Send readings” button	

	9		*Shows mockup “Successful Sending”*
	10	Presses OK	
	11		*Returns to mockup “Readings Main”*
EXTENSIONS	**Step n°**	**Readings Operator**	**System**
	9a		*Shows mockup “Failed Sending”*
	10a	Presses OK	
	11a		*Returns to mockup “Readings Main”*
SUBVARIATIONS	***Step n°***	**Readings Operator**	**System**
	8b	Returns to step #1	

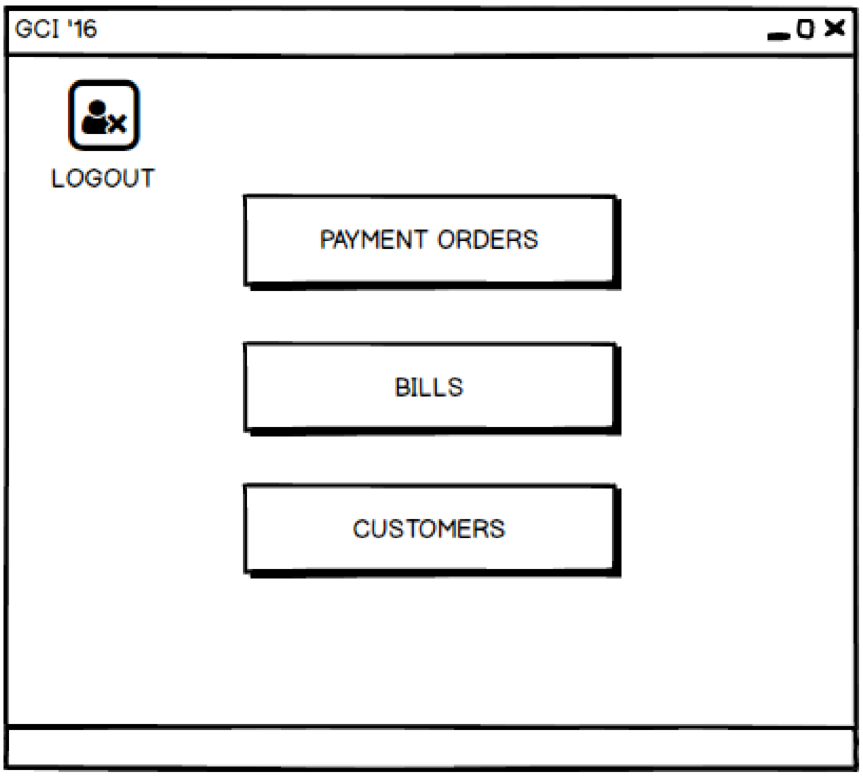
3.4 User Interface Mockups

3.4.1 Login

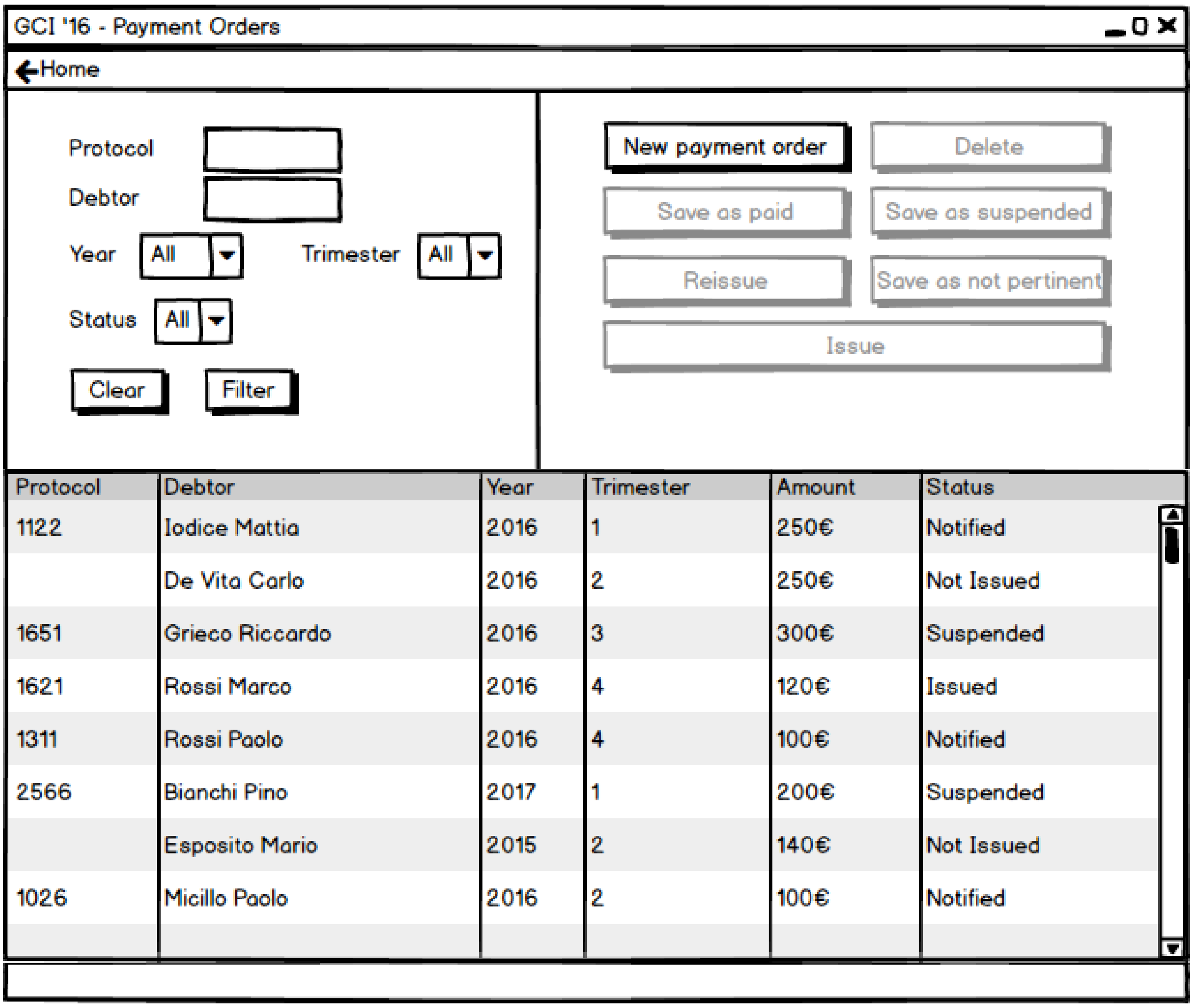




3.4.2 Main Menu



3.4.3 Payment Order

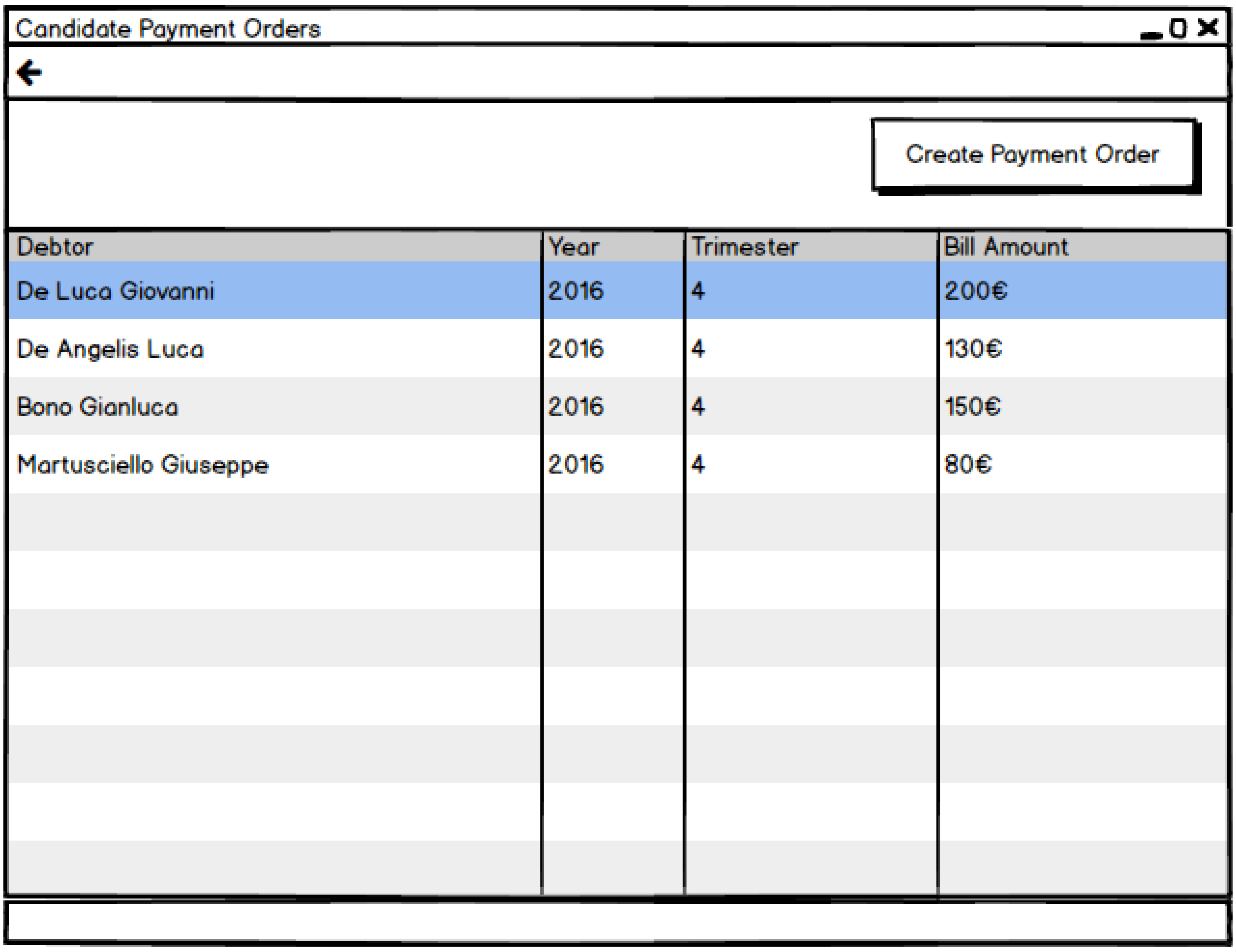

GCI '16 - Payment Orders

Home

Protocol	
Debtor	
Year	All
Trimester	All
Status	All

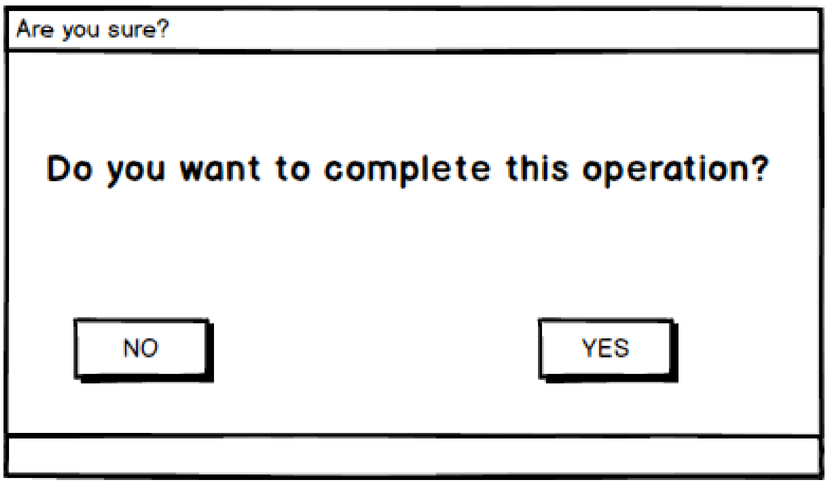
Protocol	Debtor	Year	Trimester	Amount	Status
1122	Iodice Mattia	2016	1	250€	Notified
	De Vita Carlo	2016	2	250€	Not Issued
1651	Grieco Riccardo	2016	3	300€	Suspended
1621	Rossi Marco	2016	4	120€	Issued
1311	Rossi Paolo	2016	4	100€	Notified
2566	Bianchi Pino	2017	1	200€	Suspended
	Esposito Mario	2015	2	140€	Not Issued
1026	Micillo Paolo	2016	2	100€	Notified

3.4.4 Candidate Payment Orders



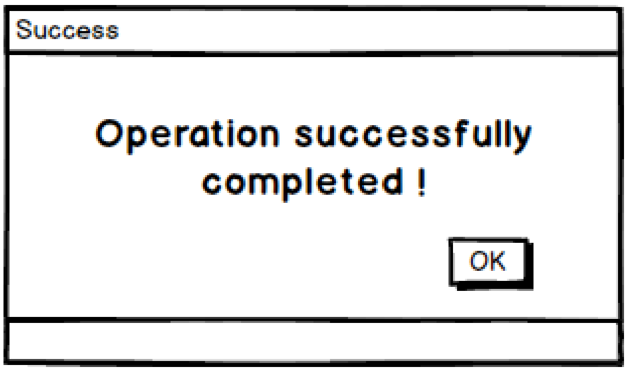
Debtor	Year	Trimester	Bill Amount
De Luca Giovanni	2016	4	200€
De Angelis Luca	2016	4	130€
Bono Gianluca	2016	4	150€
Martusciello Giuseppe	2016	4	80€

3.4.5 Confirm



Do you want to complete this operation?

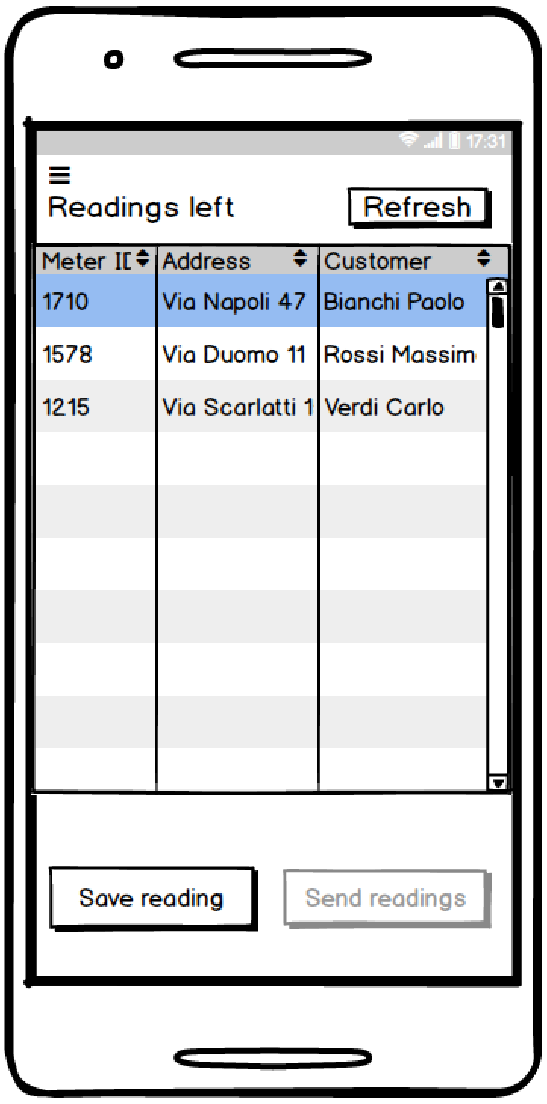
3.4.6 Operation Success



Success

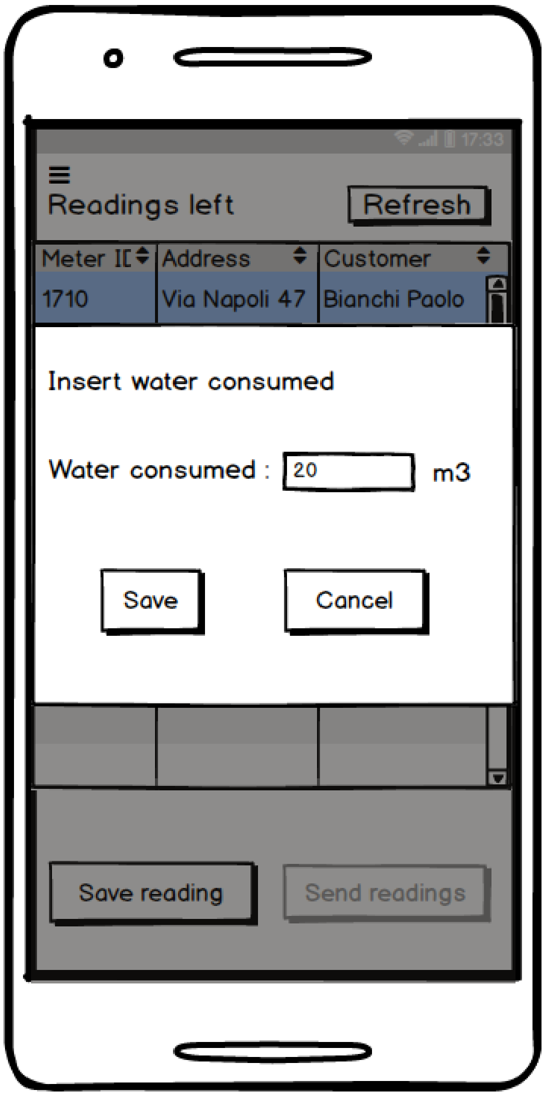
Operation successfully completed !

3.4.7 Readings Main

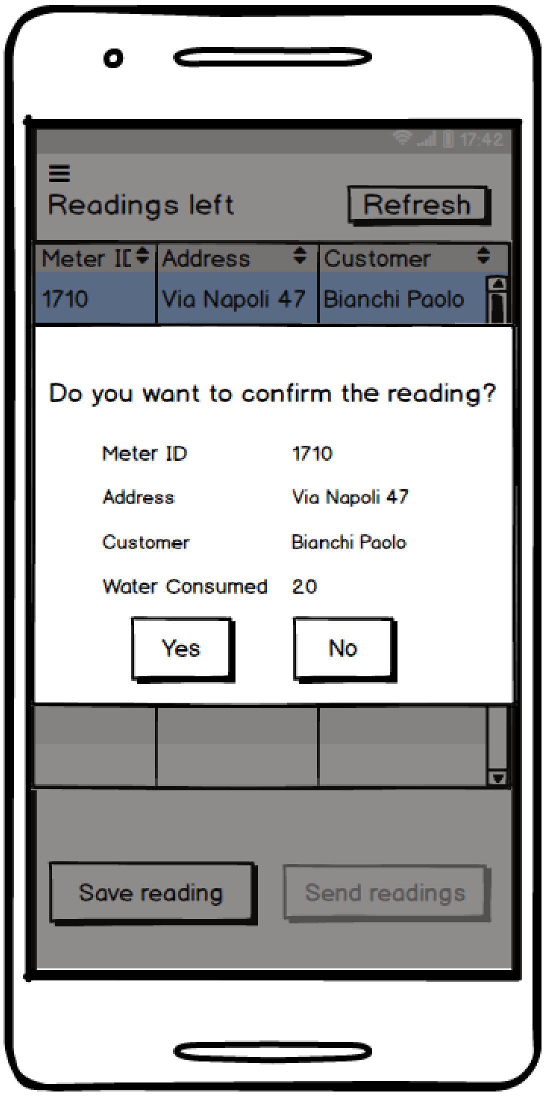


Meter ID	Address	Customer
1710	Via Napoli 47	Bianchi Paolo
1578	Via Duomo 11	Rossi Massim
1215	Via Scarlatti 1	Verdi Carlo

3.4.8 Save Reading



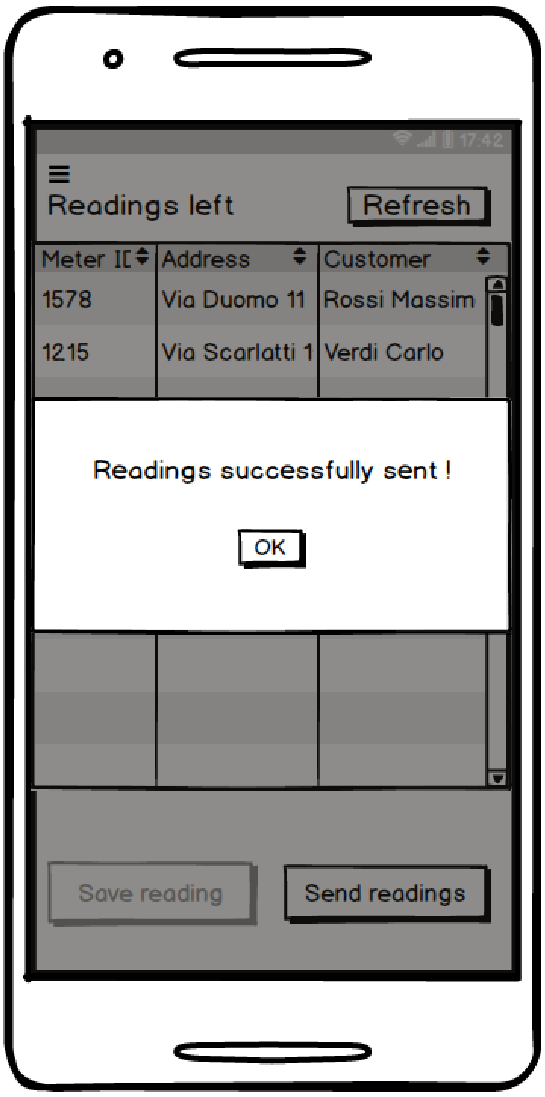
3.4.9 Confirm Reading



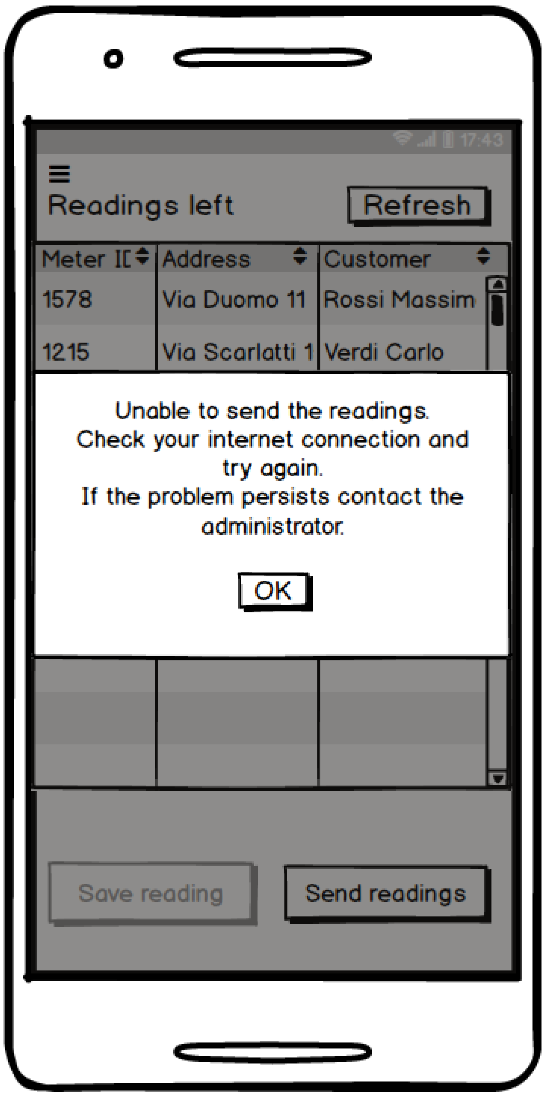
Do you want to confirm the reading?

Meter ID	1710
Address	Via Napoli 47
Customer	Bianchi Paolo
Water Consumed	20

3.4.10 Successful Sending



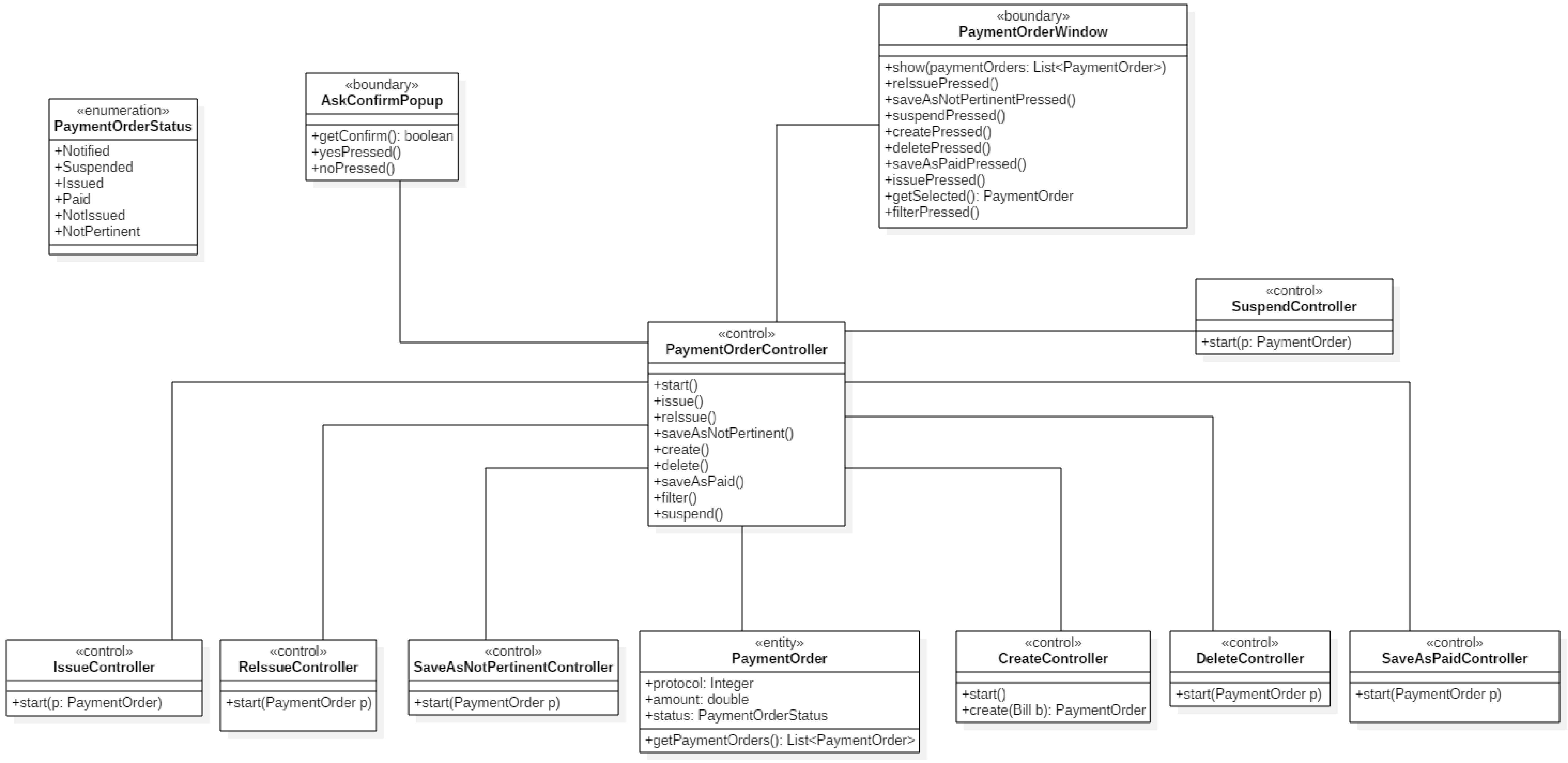
3.4.11 Failed Sending



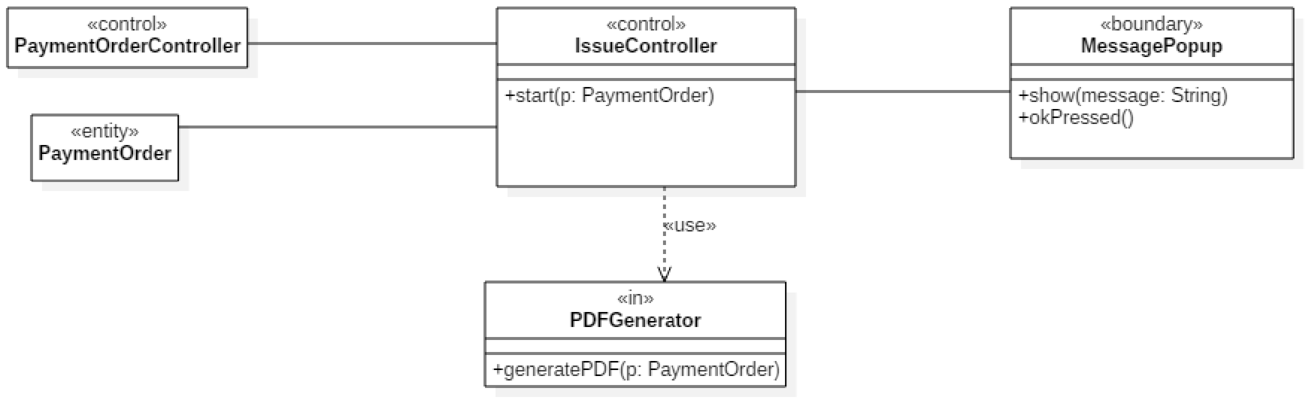
Meter ID	Address	Customer
1578	Via Duomo 11	Rossi Massim
1215	Via Scarlatti 1	Verdi Carlo

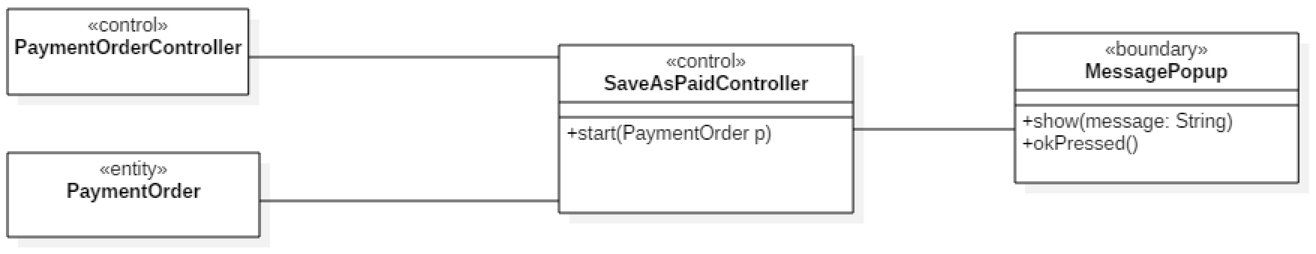
Unable to send the readings.
Check your internet connection and try again.
If the problem persists contact the administrator.

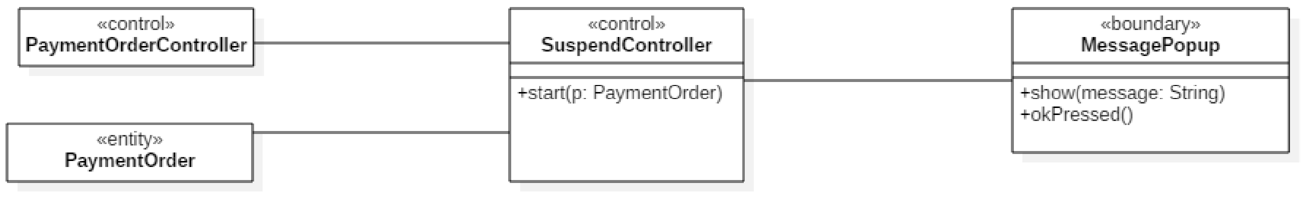
3.5 Entity-Boundary-Control Class Diagram

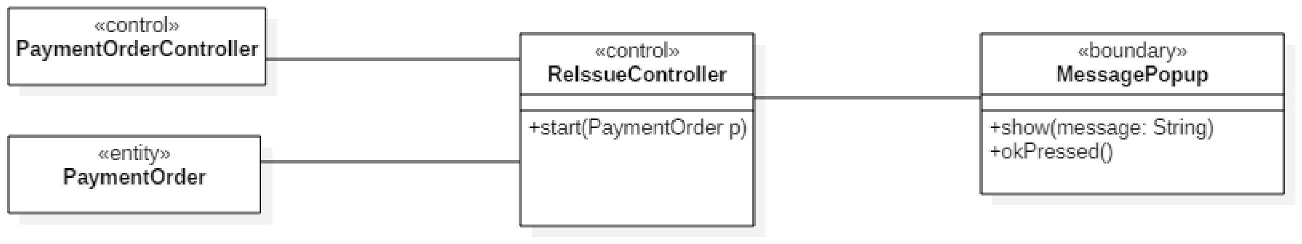


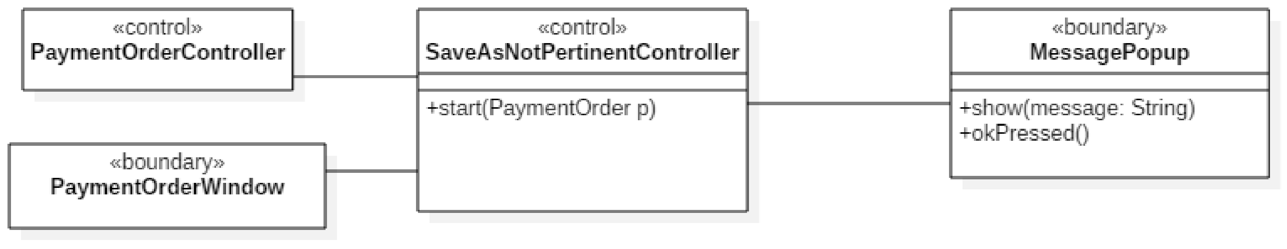
3.5.1 Desktop application controllers

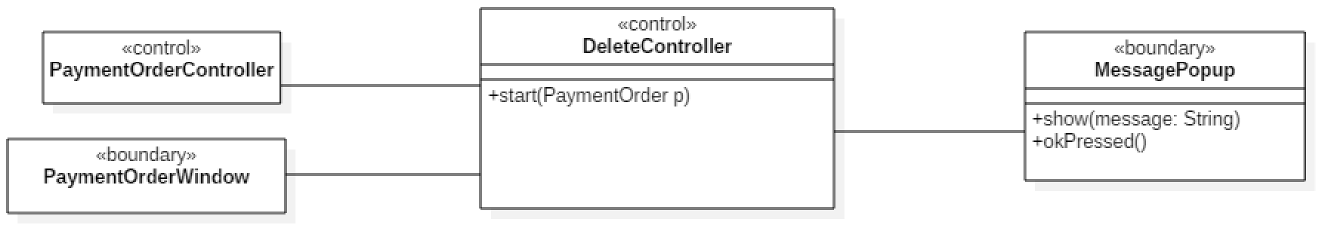


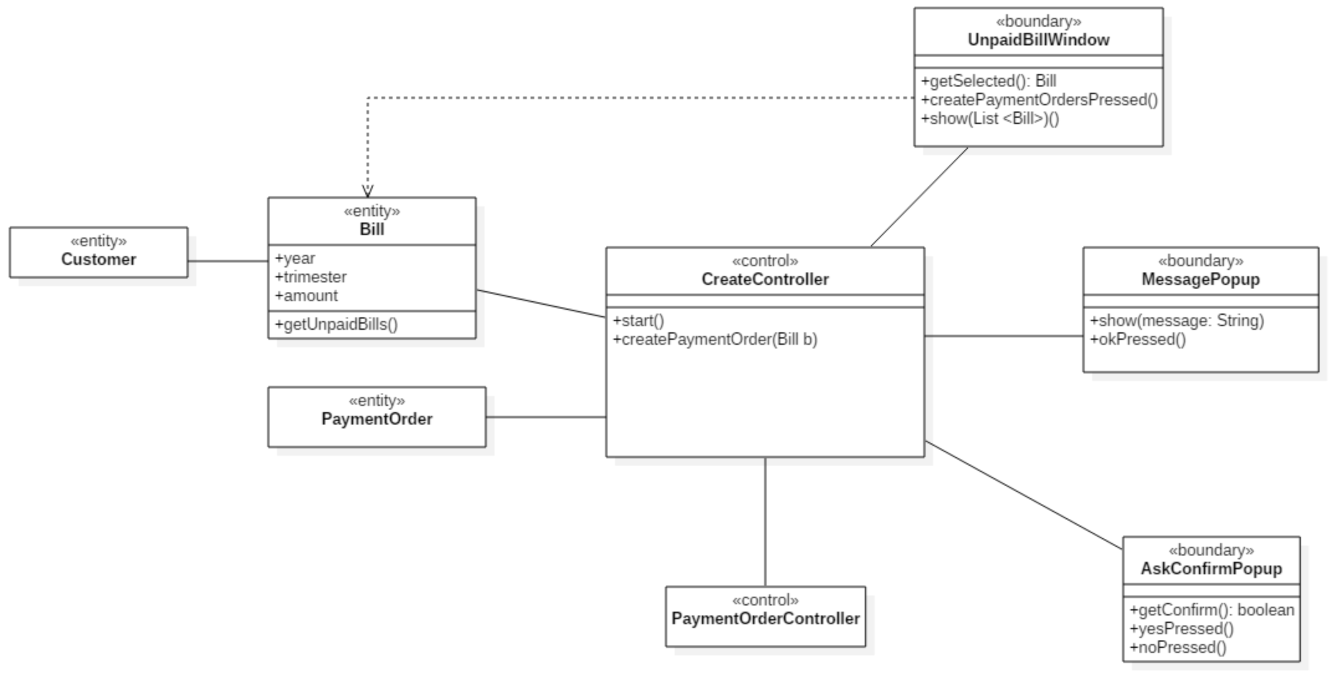




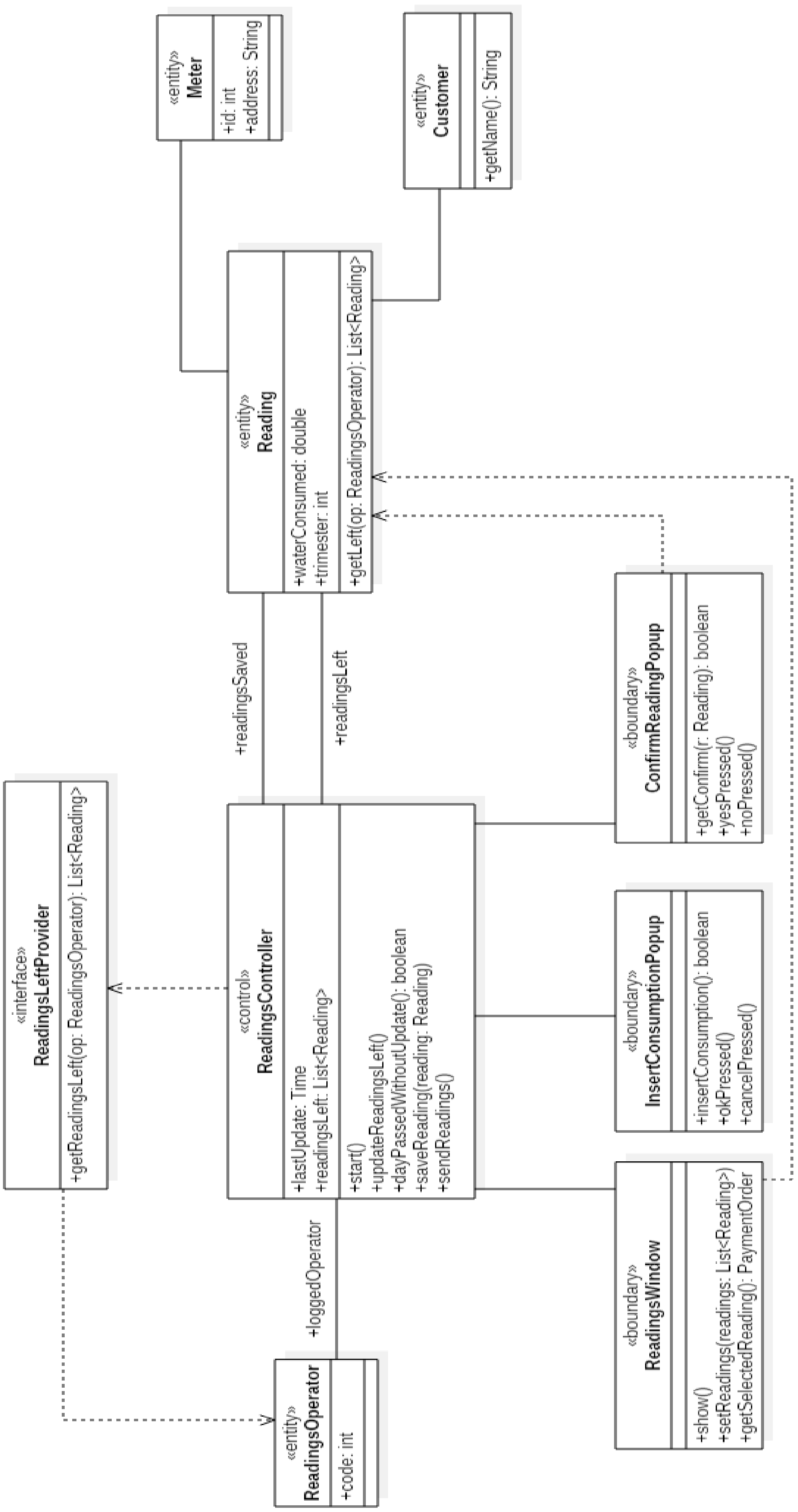



«control»
PaymentOrderController
«boundary»
PaymentOrderWindow
«control»
SaveAsNotPertinentController
+start(PaymentOrder p)
«boundary»
MessagePopup
+show(message: String)
+okPressed()


«control»
PaymentOrderController
«boundary»
PaymentOrderWindow
«control»
DeleteController
+start(PaymentOrder p)
«boundary»
MessagePopup
+show(message: String)
+okPressed()

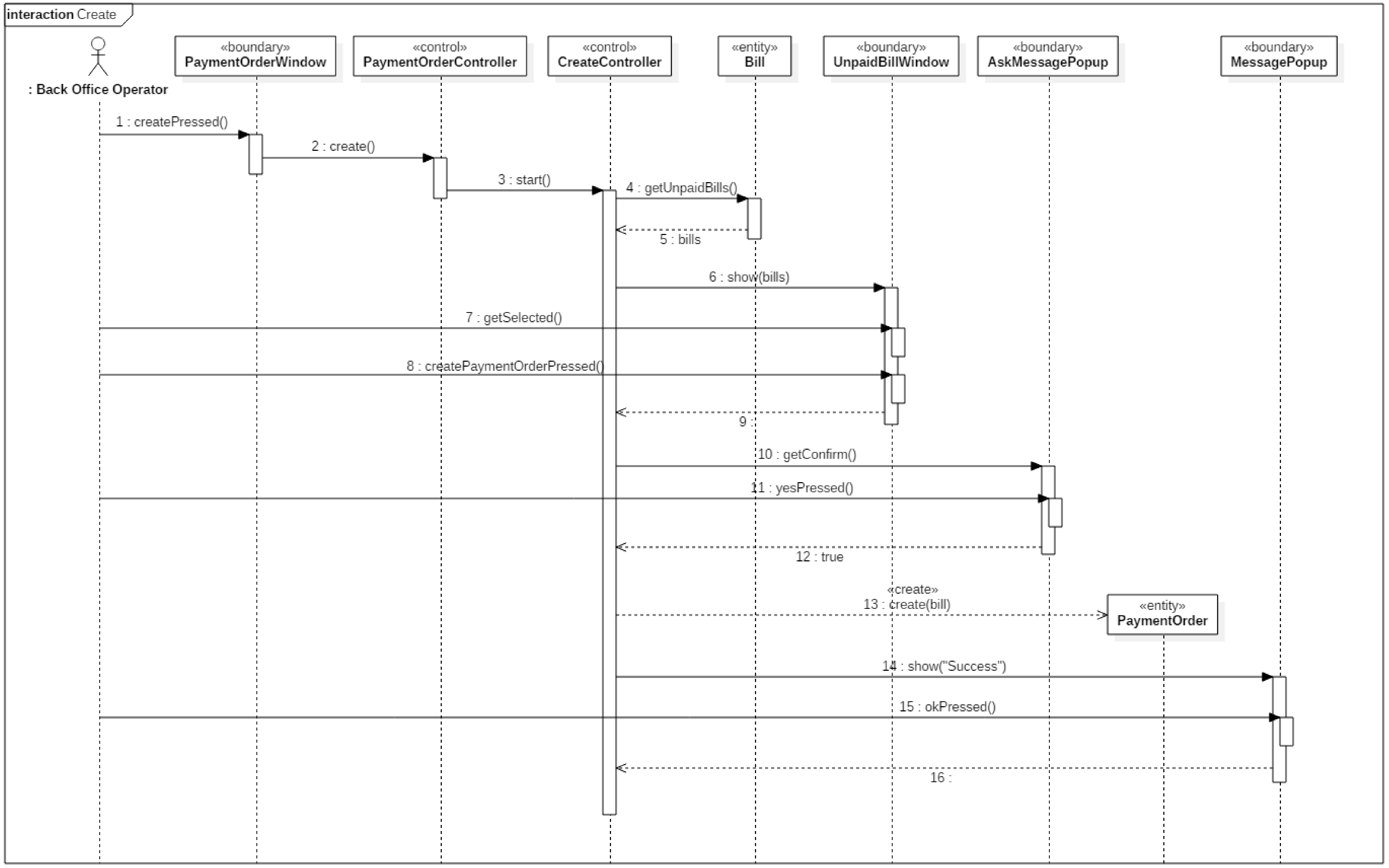

«boundary»
UnpaidBillWindow
+getSelected(): Bill
+createPaymentOrdersPressed()
+show(List <Bill>)()
«entity»
Customer
«entity»
Bill
+year
+trimester
+amount
+getUnpaidBills()
«control»
CreateController
+start()
+createPaymentOrder(Bill b)
«boundary»
MessagePopup
+show(message: String)
+okPressed()
«entity»
PaymentOrder
«control»
PaymentOrderController
«boundary»
AskConfirmPopup
+getConfirm(): boolean
+yesPressed()
+noPressed()

3.5.2 Mobile application controller

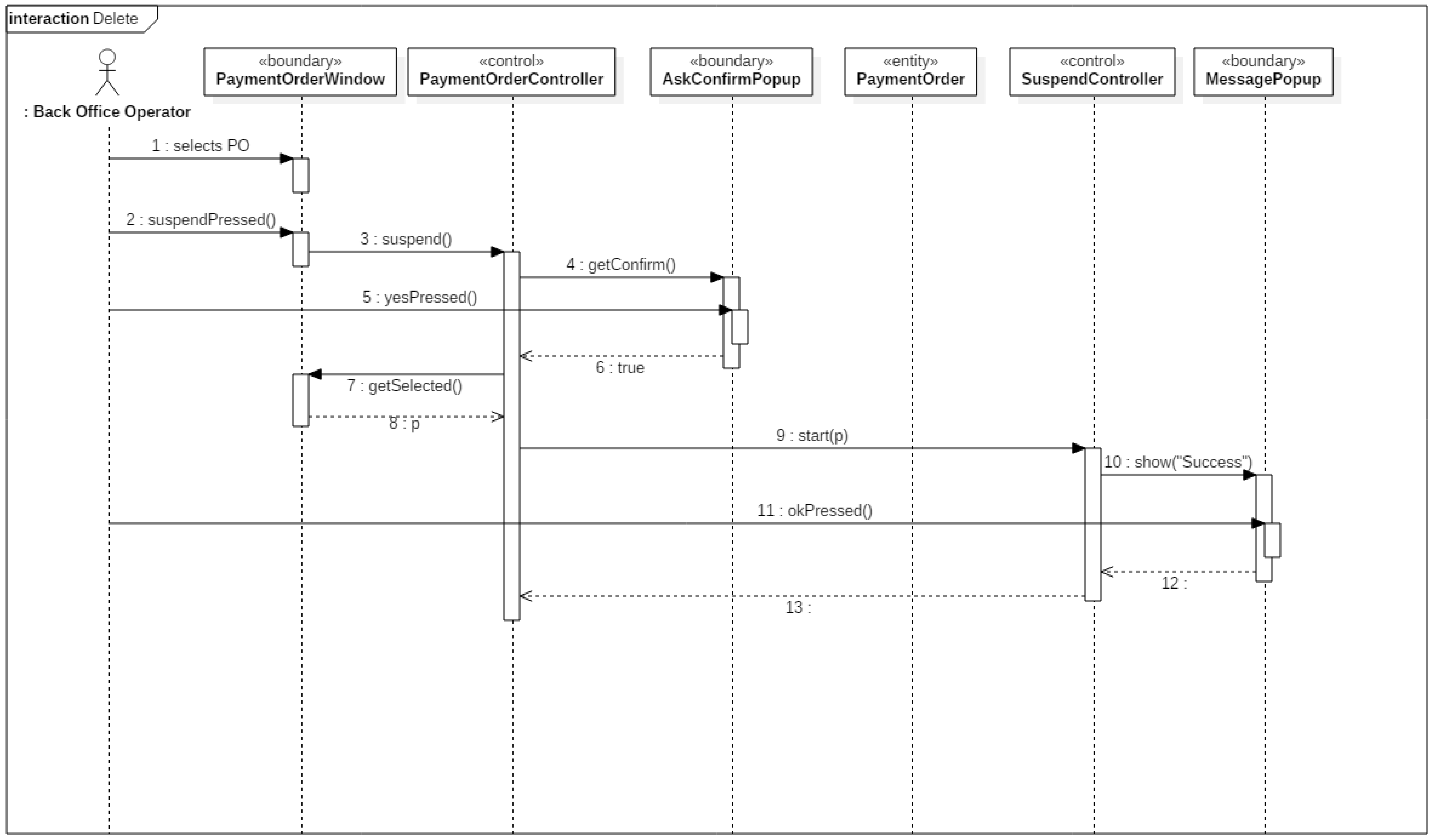


3.6 Sequence Diagrams

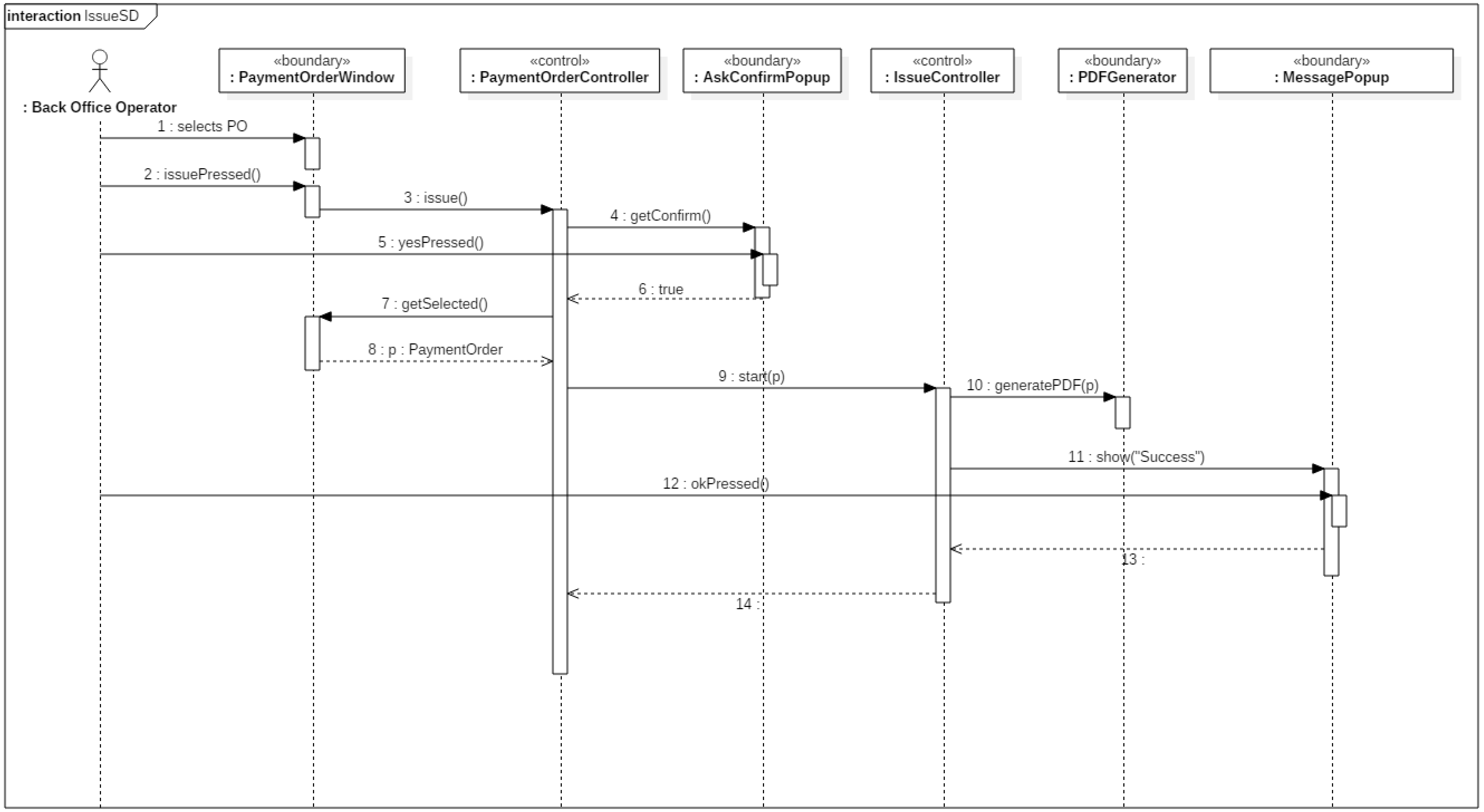
3.6.1 Create payment order



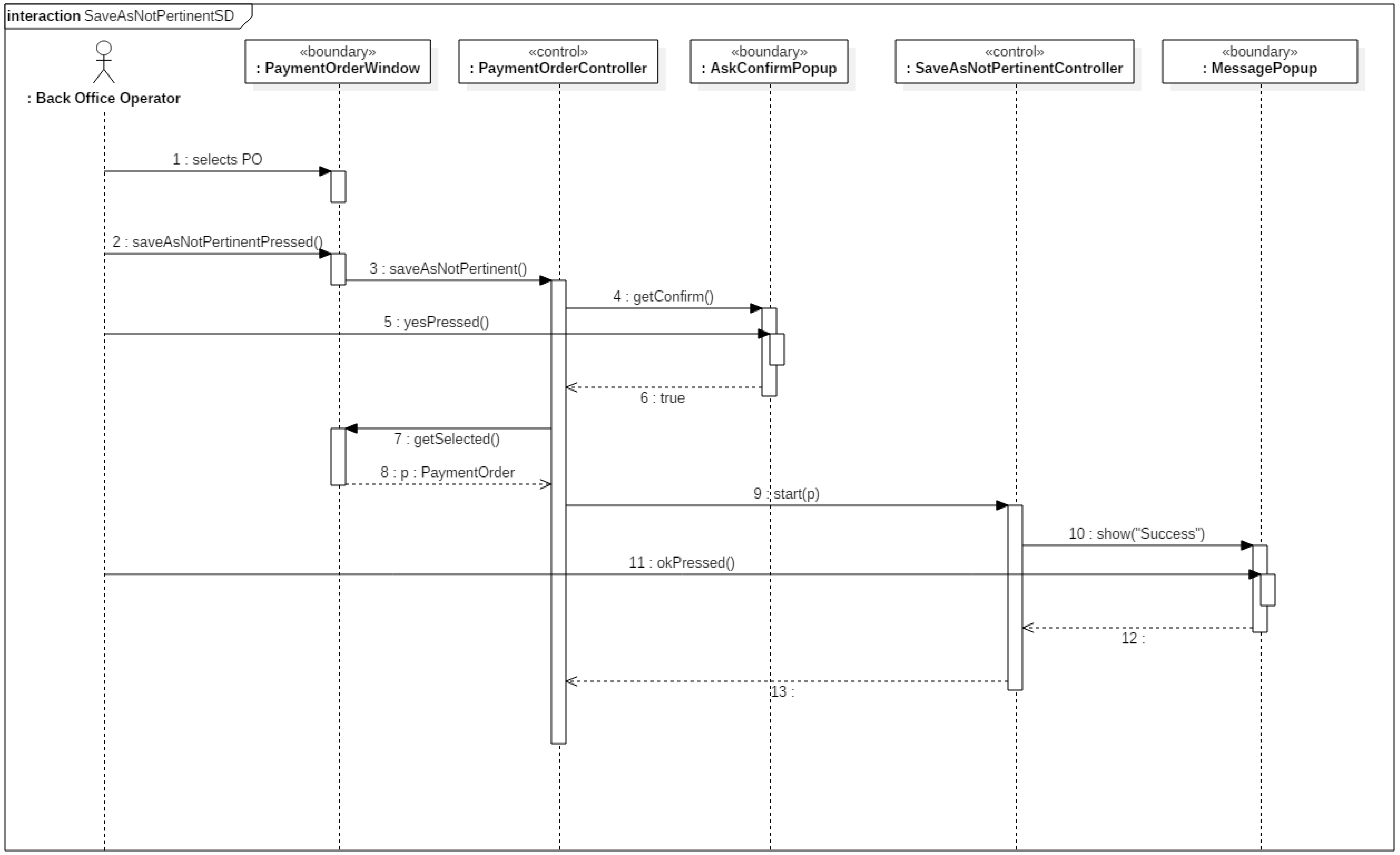
3.6.2 Delete payment order



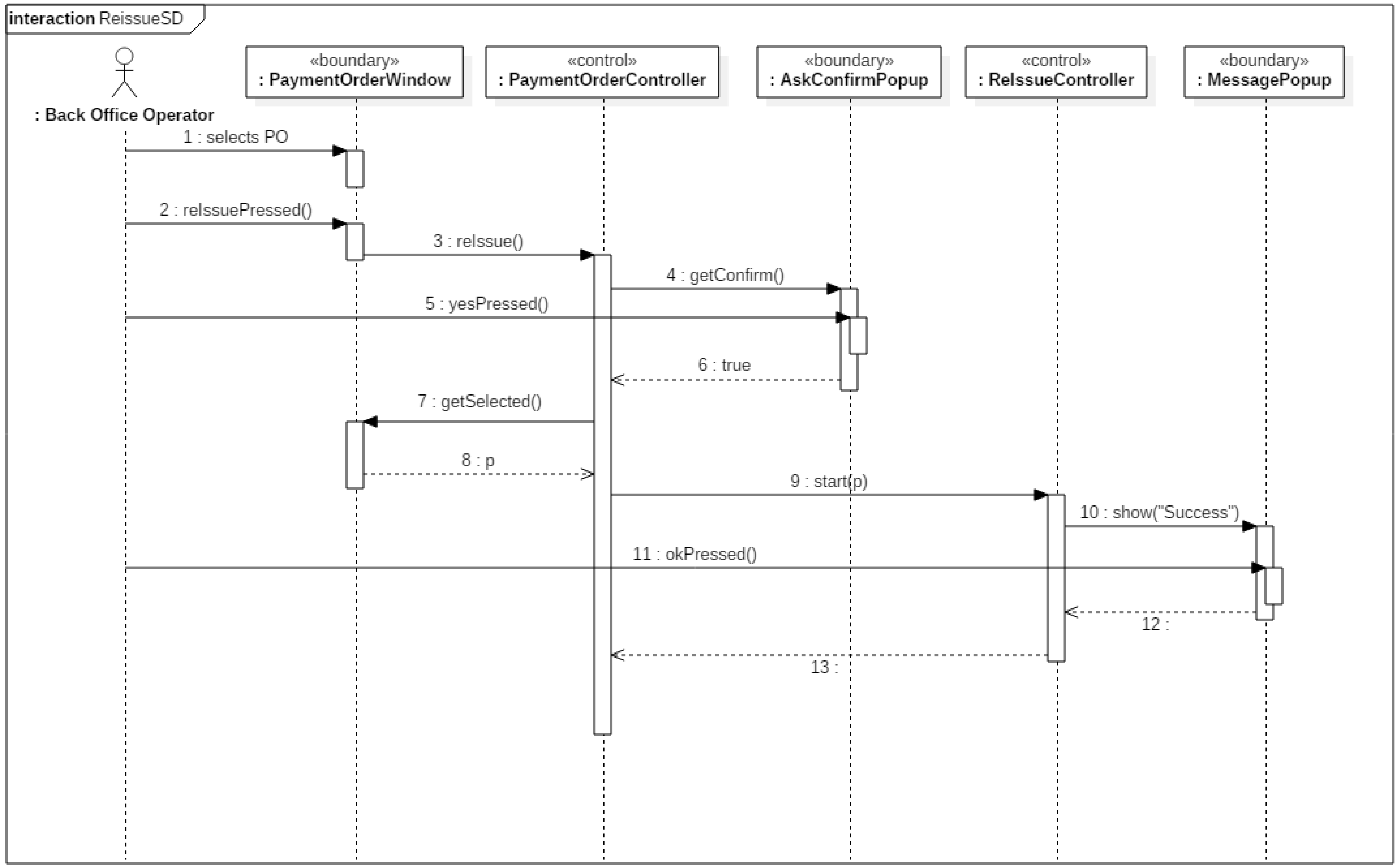
3.6.3 Issue payment order



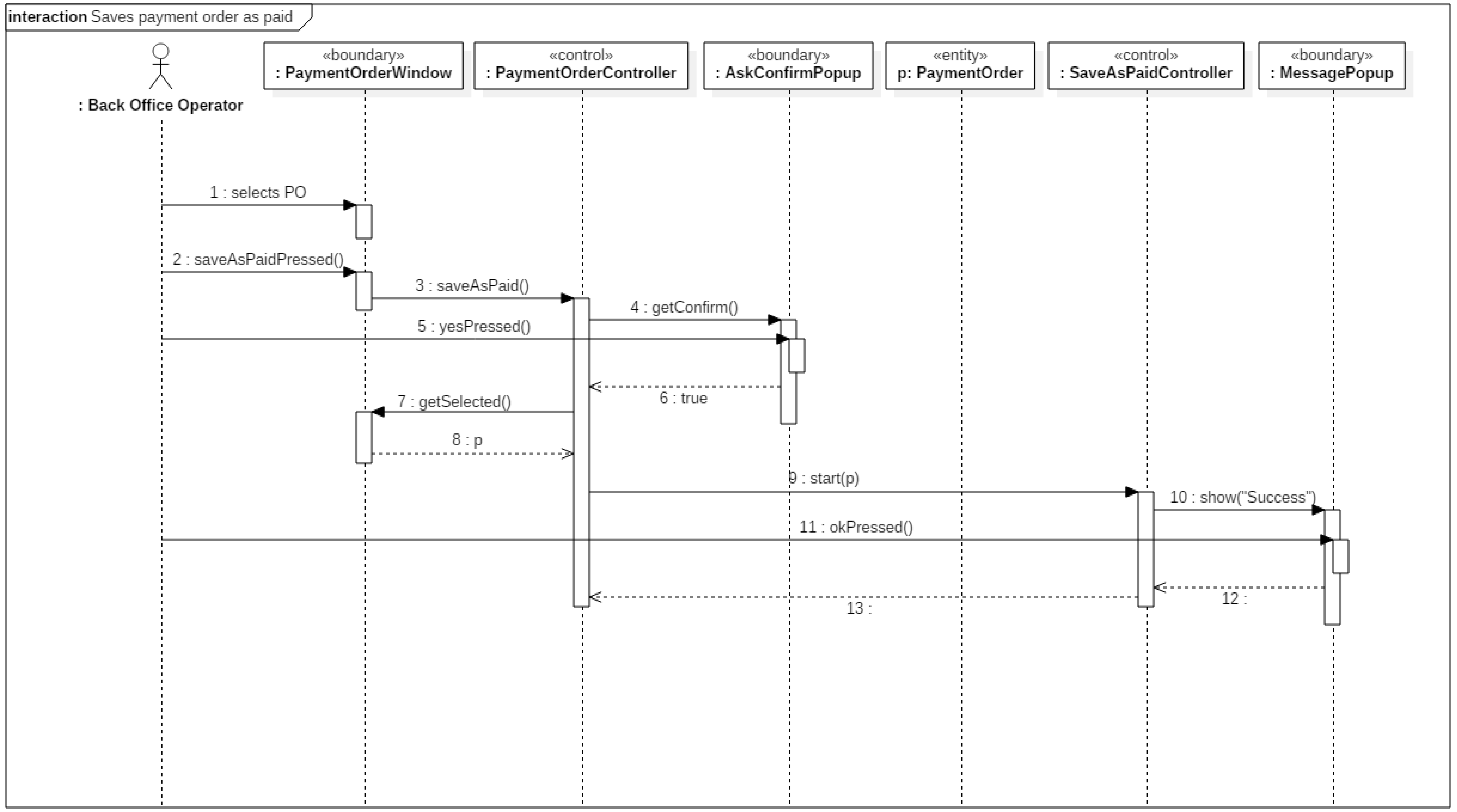
3.6.4 Save payment order as not pertinent


interaction SaveAsNotPertinentSD
: Back Office Operator
«boundary» : PaymentOrderWindow
«control» : PaymentOrderController
«boundary» : AskConfirmPopup
«control» : SaveAsNotPertinentController
«boundary» : MessagePopup
1 : selects PO
2 : saveAsNotPertinentPressed()
3 : saveAsNotPertinent()
4 : getConfirm()
5 : yesPressed()
6 : true
7 : getSelected()
8 : p : PaymentOrder
9 : start(p)
10 : show("Success")
11 : okPressed()
12 :
13 :

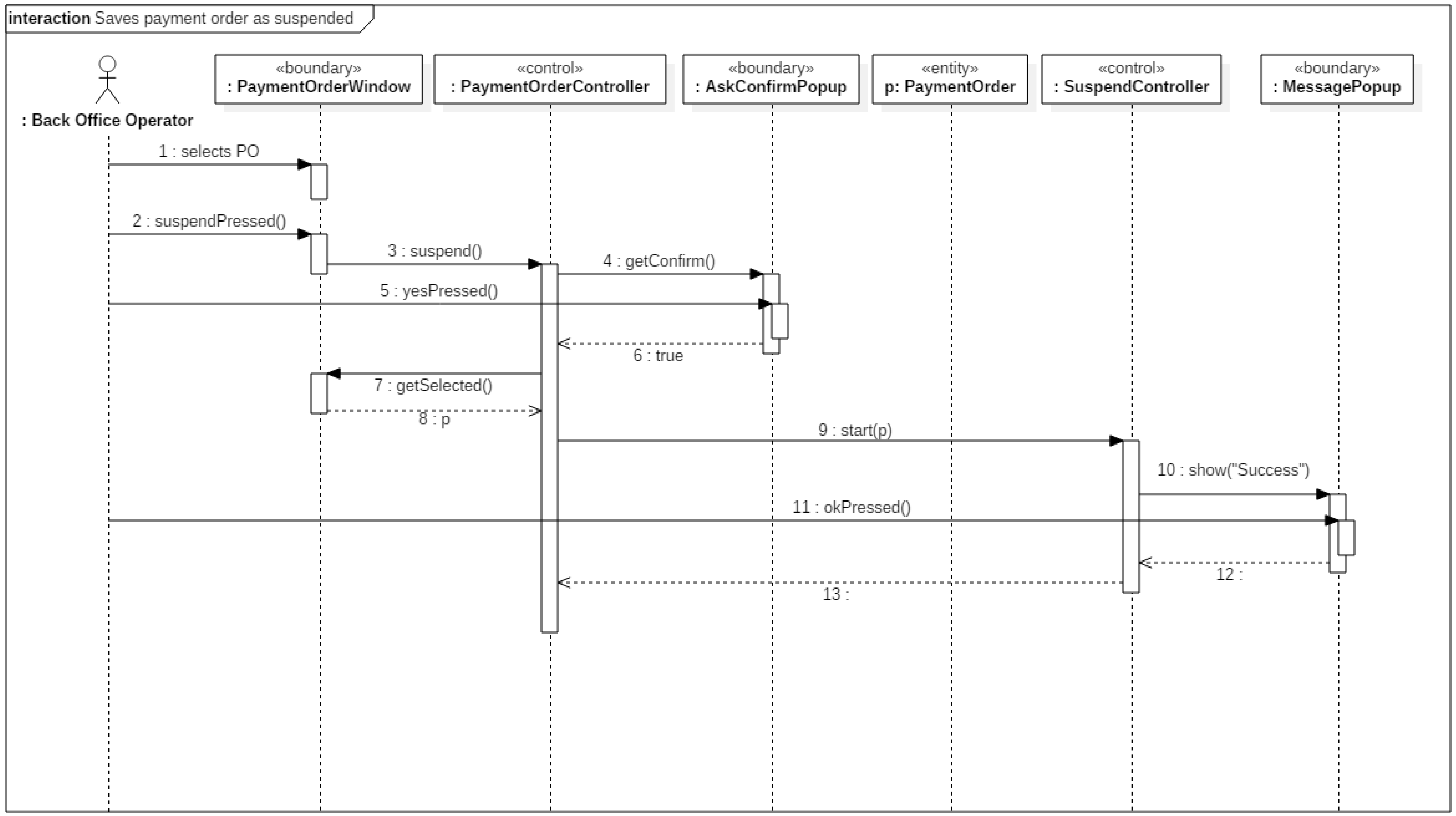
3.6.5 Reissue payment order



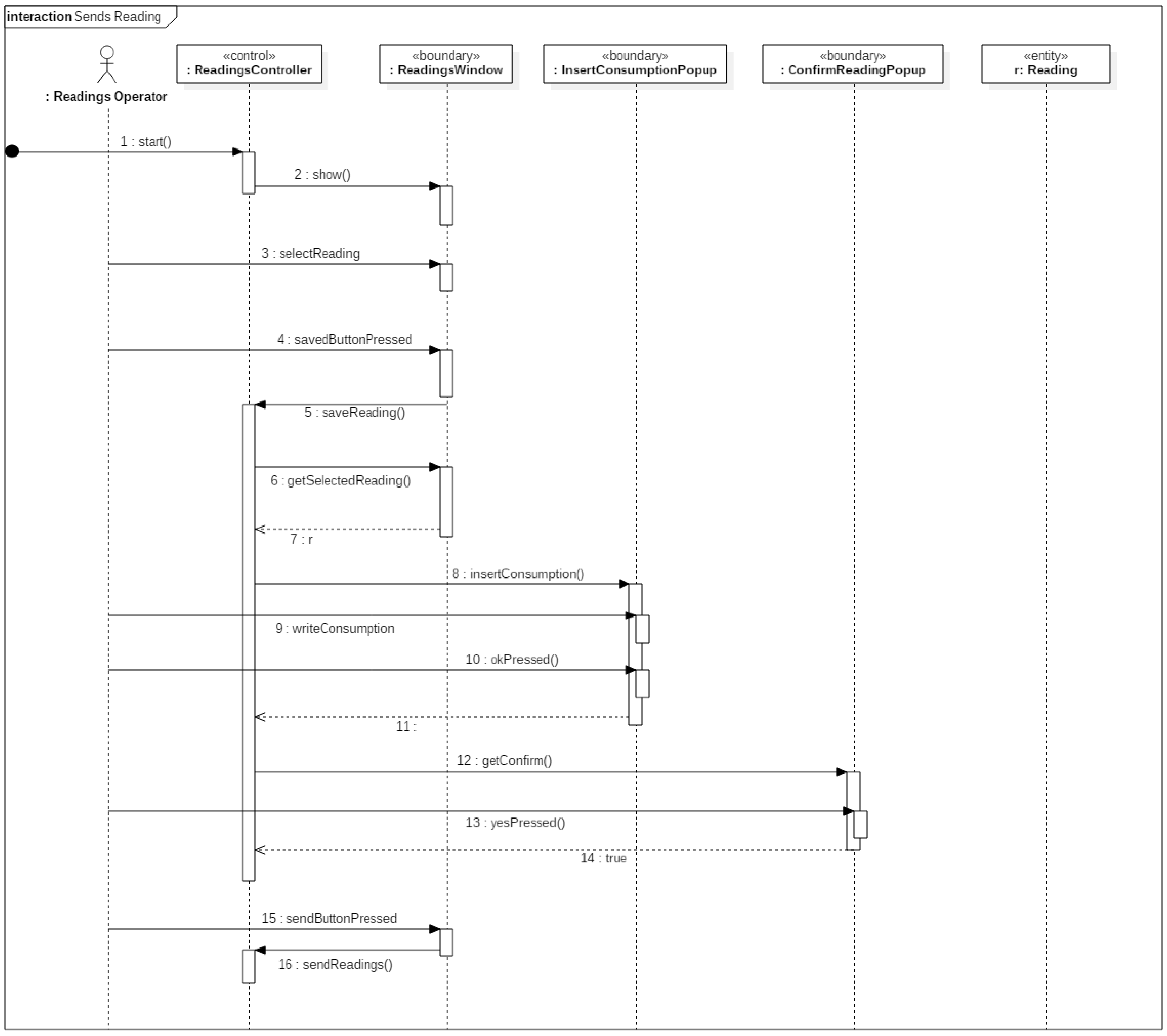
3.6.6 Save payment order as paid



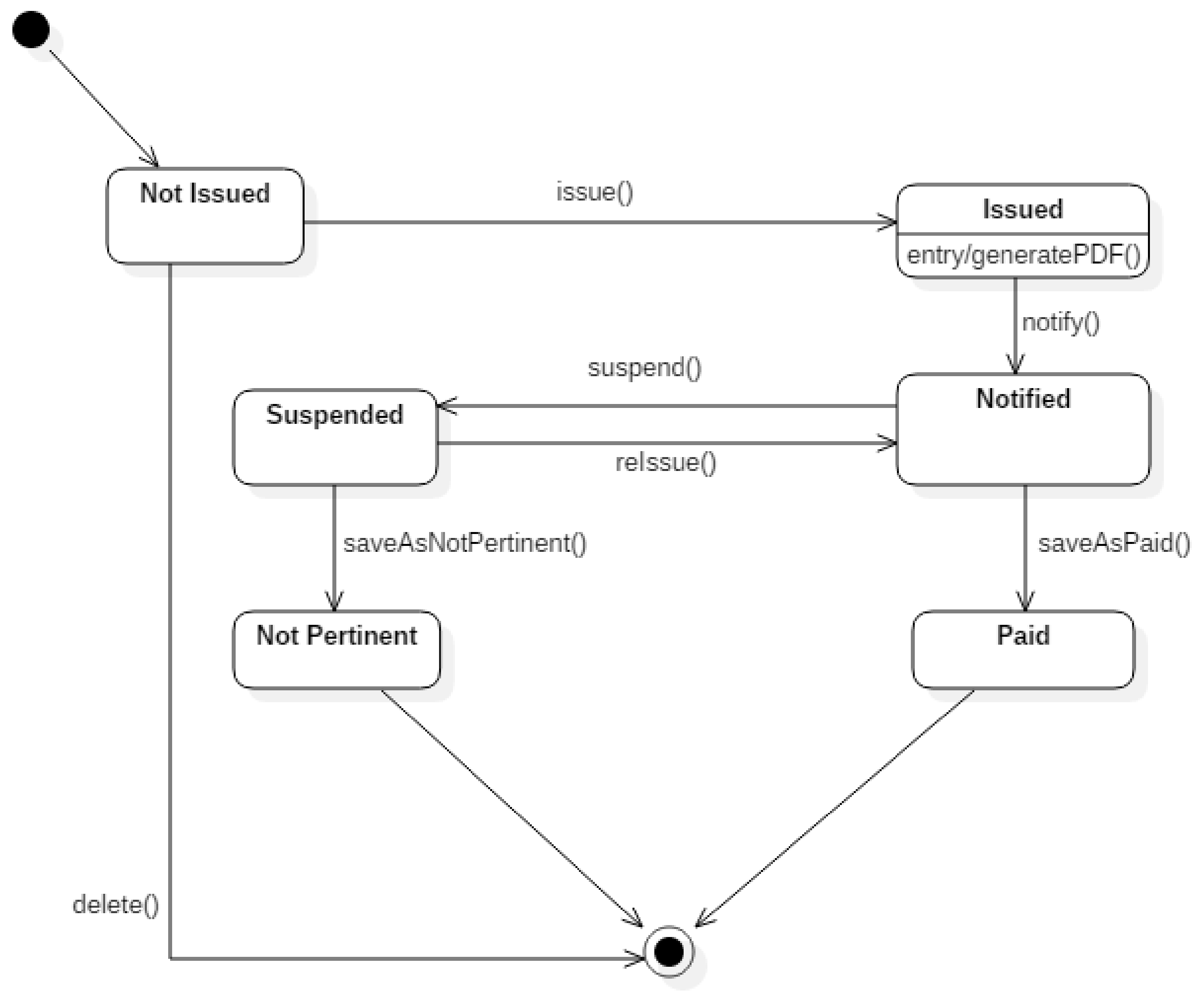
3.6.7 Save payment order as suspended



3.6.8 Send readings



3.7 Payment Order Statechart Diagram

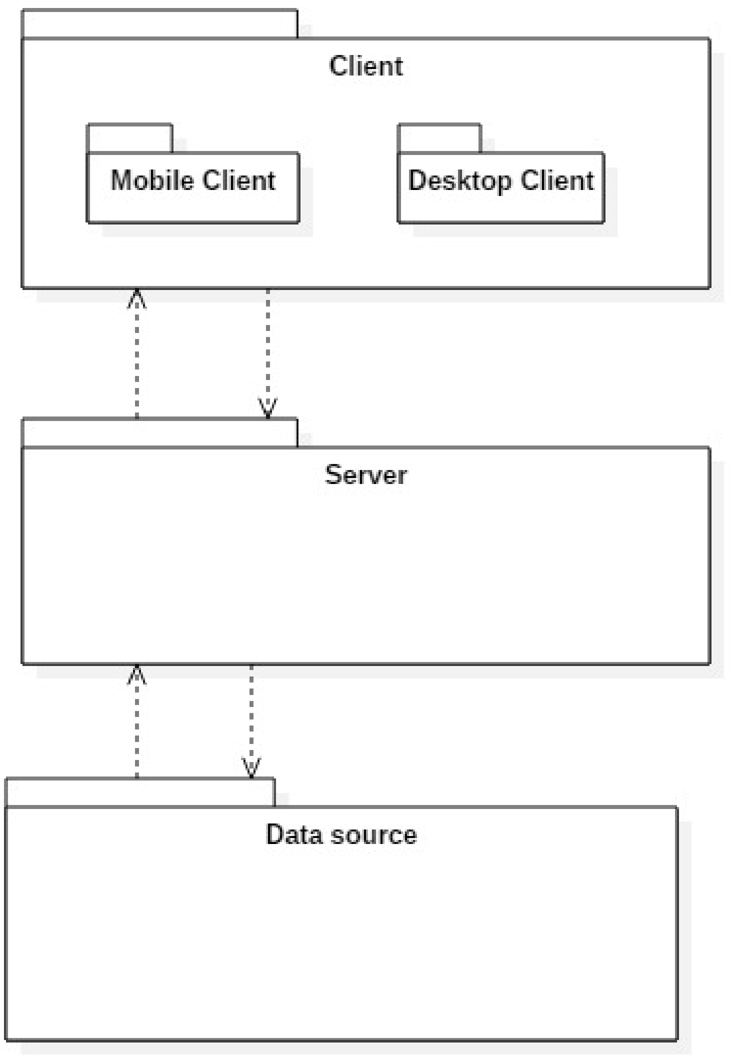


4 Design documentation

4.1 System design

4.1.1 Software architecture

The system division is based on the Three-Tier Architecture, which divides the system into three modules: client, server, and data source.
In this way most of the business logic is located in a central server, the code is more scalable and maintainable and the client is independent of the data source.



Client:
Consists on the application which directly interacts with the users.
This module is divided into two parts: a mobile application for readings operator, which is the mobile app that lets the users read the consumptions from the assigned meters, and a desktop application for back office operators.

Server:
Represents the application's logical component, which provides authentication tokens, performs and verifies the correctness of the required operations, for example the status of a payment order.
It was decided to use only one server to handle application requests, because it is estimated that the number of simultaneous connections is not high.

Data source:
Relational DBMS in which persistent data are saved.

4.1.2 Client server communication

Client and server communicate using HTTP messages. The server provides a session cookie after a successful login request and the client must send back the cookie for each further communication. The server listens on port 8081 and replies to client requests with the following response codes:

Response code	Reason phrase	Description
200	OK	The request has been successfully accomplished.
500	Internal server error	The request could not be accomplished due to an error encountered in the server.
461	Wrong id or password	The user has submitted a wrong id or password.
462	No session	The client has not sent a valid session cookie or the cookie sent has expired.
463	Missing parameter	The request expected a parameter which has not been sent.
464	Bad parameter values	One or more parameters presented an unexpected value.
465	Not practicable action	The requested action could not be applied to the given parameter.

4.2 Technologies

Technology	Version	Usages
Java	JDK 1.8	Code language for all applications.
Apache Tomcat [1]	8.5	Server.
Java EE	Java EE 6	Servlet for server web services.
JSON [2]		Client and server data exchange.
Oracle Database	11g Express Edition	Database.
Android	SDK 16 – API 4.1 JDK 1.7	Mobile application for Readings Operators.
Netbeans IDE	8.2	Code development for server and desktop applications.
Android Studio	2.3.3	Code development for Android environment.

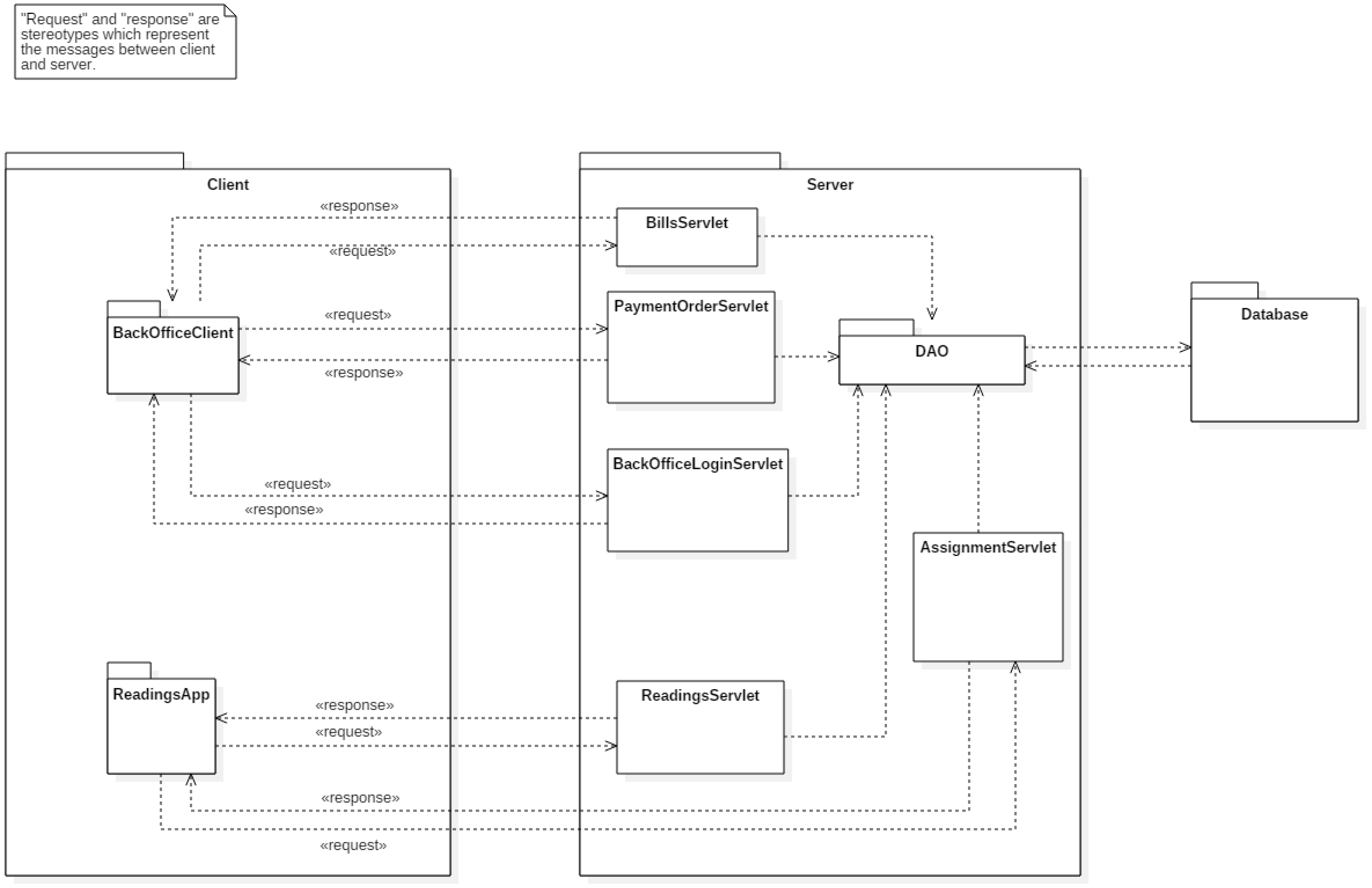
4.2.1 Frameworks and Libraries

Name	Usages	References
Gson	Convert an object to the corresponding JSON string and vice versa	https://github.com/google/gson/blob/master/UserGuide.md
iText	Create and manipulate PDF files in Java	https://developers.itextpdf.com/apis
Oracle JDBC	Drivers for Oracle DBMS	https://docs.oracle.com/cd/E11882_01/java.112/e16548/toc.htm
Mockito	Create stub classes for testing	http://site.mockito.org/
jUnit 4.9	Unit testing	http://junit.org/junit4/

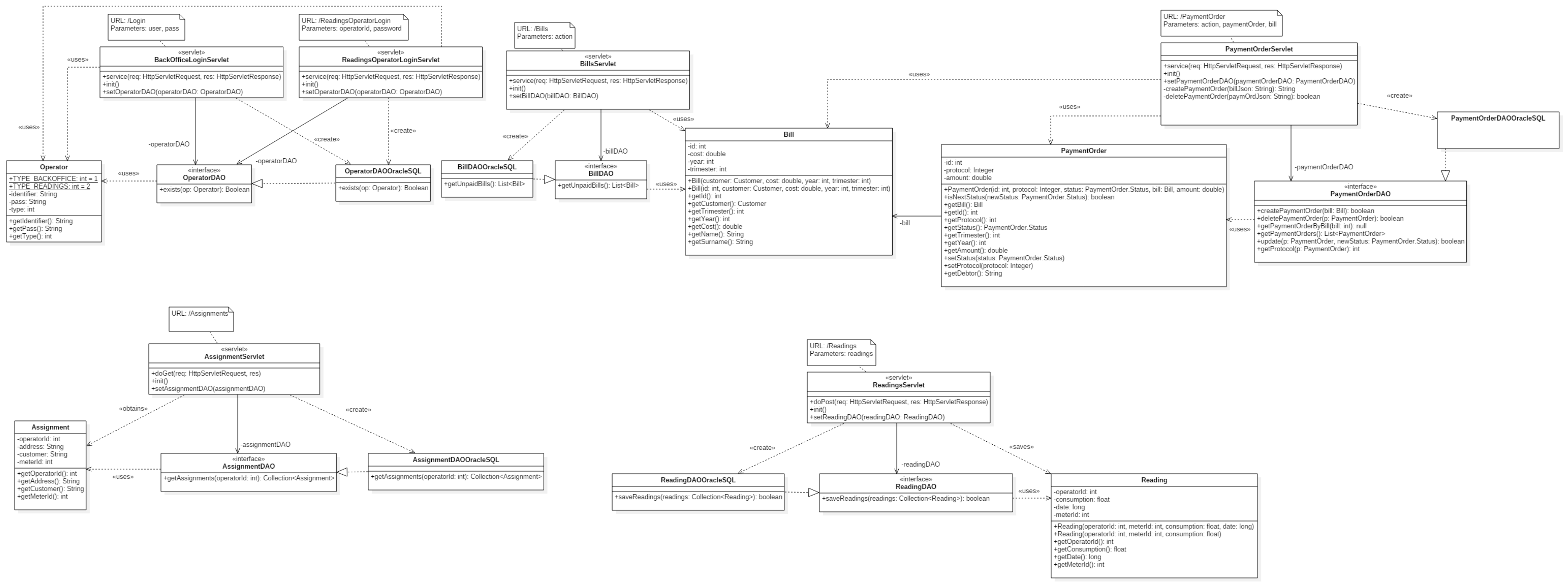
4.3 Object design

4.3.1 Class diagrams

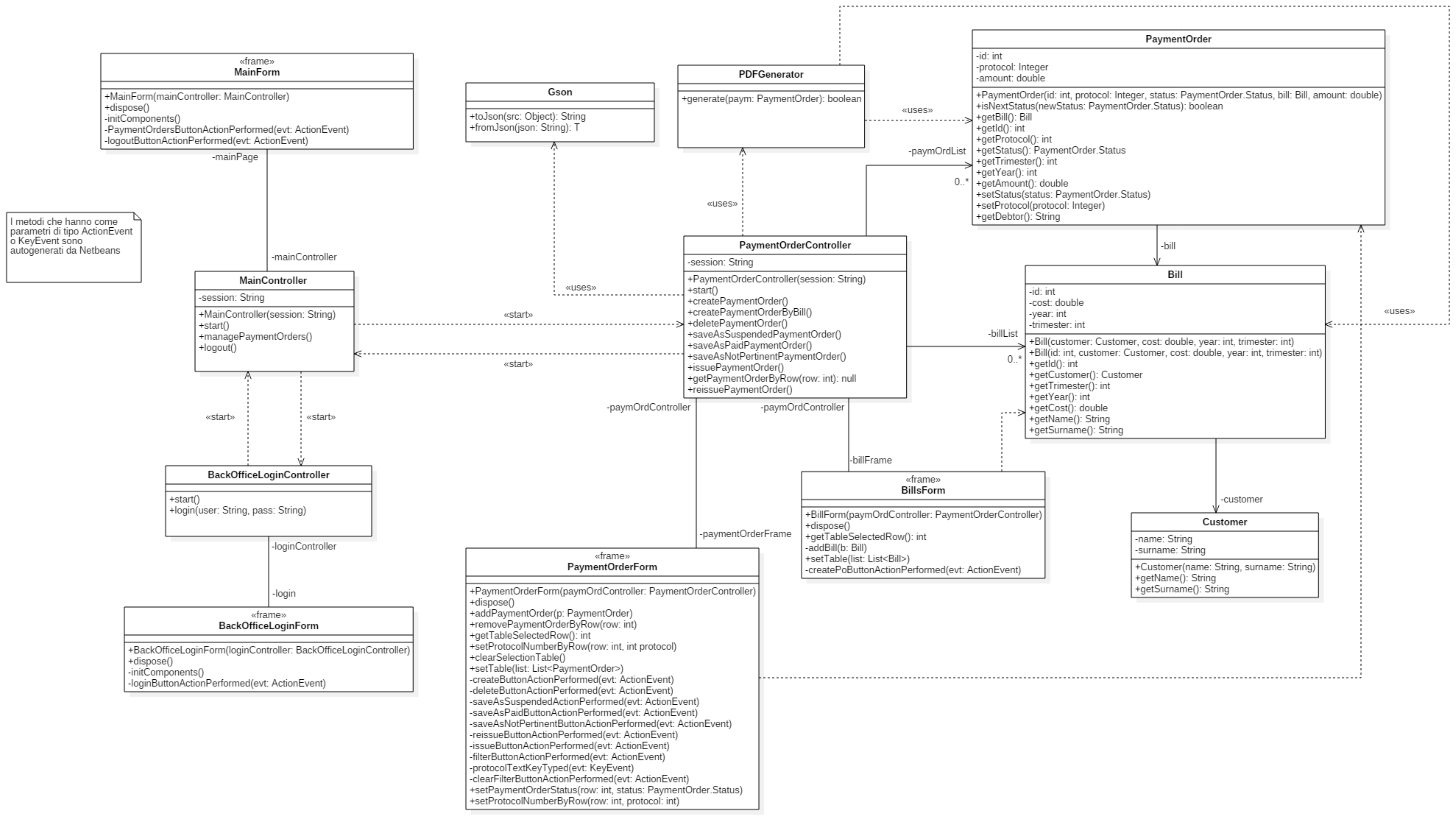
4.3.1.1 System



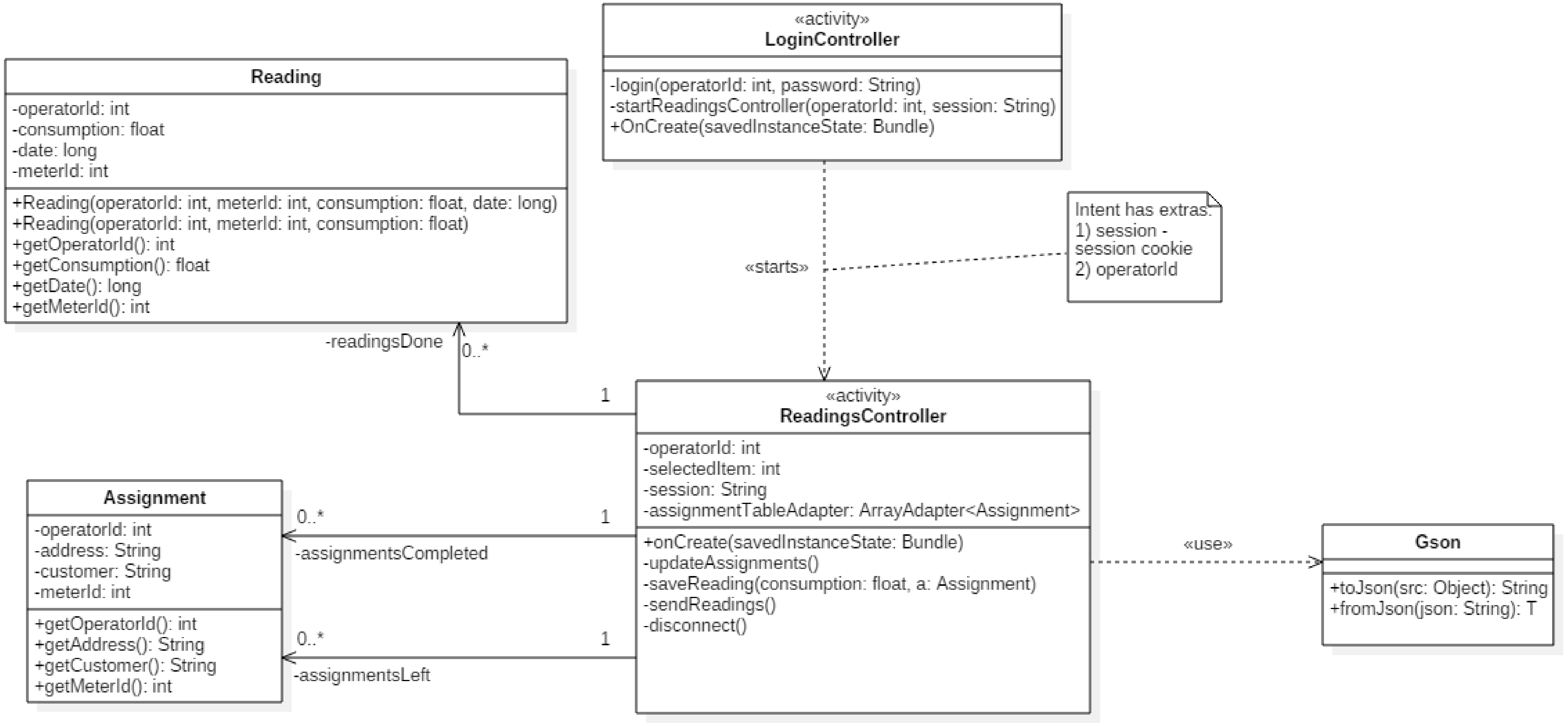
4.3.1.2 Server


URL: /Login
Parameters: user, pass
«servlet»
BackOfficeLoginServlet
+service(req: HttpServletRequest, res: HttpServletResponse)
+init()
+setOperatorDAO(operatorDAO: OperatorDAO)
URL: /ReadingsOperatorLogin
Parameters: operatorId, password
«servlet»
ReadingsOperatorLoginServlet
+service(req: HttpServletRequest, res: HttpServletResponse)
+init()
+setOperatorDAO(operatorDAO: OperatorDAO)
«uses»
«uses»
-operatorDAO
-operatorDAO
«create»
«create»
Operator
+TYPE_BACKOFFICE: int = 1
+TYPE_READINGS: int = 2
-identifier: String
-pass: String
-type: int
+getIdentifier(): String
+getPass(): String
+getType(): int
«uses»
«interface»
OperatorDAO
+exists(op: Operator): Boolean
OperatorDAOOracleSQL
+exists(op: Operator): Boolean
URL: /Bills
Parameters: action
«servlet»
BillsServlet
+service(req: HttpServletRequest, res: HttpServletResponse)
+init()
+setBillDAO(billDAO: BillDAO)
«create»
-billDAO
«uses»
BillDAOOracleSQL
+getUnpaidBills(): List<Bill>
«interface»
BillDAO
+getUnpaidBills(): List<Bill>
«uses»
Bill
-id: int
-cost: double
-year: int
-trimester: int
+Bill(customer: Customer, cost: double, year: int, trimester: int)
+Bill(id: int, customer: Customer, cost: double, year: int, trimester: int)
+getId(): int
+getCustomer(): Customer
+getTrimester(): int
+getYear(): int
+getCost(): double
+getName(): String
+getSurname(): String
URL: /PaymentOrder
Parameters: action, paymentOrder, bill
PaymentOrderServlet
+service(req: HttpServletRequest, res: HttpServletResponse)
+init()
+setPaymentOrderDAO(paymentOrderDAO: PaymentOrderDAO)
-createPaymentOrder(billJson: String): String
-deletePaymentOrder(paymOrdJson: String): boolean
«uses»
«uses»
«create»
-paymentOrderDAO
PaymentOrderDAOOracleSQL
PaymentOrder
-id: int
-protocol: Integer
-amount: double
+PaymentOrder(id: int, protocol: Integer, status: PaymentOrder.Status, bill: Bill, amount: double)
+isNextStatus(newStatus: PaymentOrder.Status): boolean
+getBill(): Bill
+getId(): int
+getProtocol(): int
+getStatus(): PaymentOrder.Status
+getTrimester(): int
+getYear(): int
+getAmount(): double
+setStatus(status: PaymentOrder.Status)
+setProtocol(protocol: Integer)
+getDebtor(): String
-bill
«uses»
«interface»
PaymentOrderDAO
+createPaymentOrder(bill: Bill): boolean
+deletePaymentOrder(p: PaymentOrder): boolean
+getPaymentOrderByBill(bill: int): null
+getPaymentOrders(): List<PaymentOrder>
+update(p: PaymentOrder, newStatus: PaymentOrder.Status): boolean
+getProtocol(p: PaymentOrder): int
URL: /Assignments
«servlet»
AssignmentServlet
+doGet(req: HttpServletRequest, res)
+init()
+setAssignmentDAO(assignmentDAO)
«obtains»
-assignmentDAO
«create»
Assignment
-operatorId: int
-address: String
-customer: String
-meterId: int
+getOperatorId(): int
+getAddress(): String
+getCustomer(): String
+getMeterId(): int
«uses»
«interface»
AssignmentDAO
+getAssignments(operatorId: int): Collection<Assignment>
AssignmentDAOOracleSQL
+getAssignments(operatorId: int): Collection<Assignment>
URL: /Readings
Parameters: readings
«servlet»
ReadingsServlet
+doPost(req: HttpServletRequest, res: HttpServletResponse)
+init()
+setReadingDAO(readingDAO: ReadingDAO)
«create»
-readingDAO
«saves»
ReadingDAOOracleSQL
+saveReadings(readings: Collection<Reading>): boolean
«interface»
ReadingDAO
+saveReadings(readings: Collection<Reading>): boolean
«uses»
Reading
-operatorId: int
-consumption: float
-date: long
-meterId: int
+Reading(operatorId: int, meterId: int, consumption: float, date: long)
+Reading(operatorId: int, meterId: int, consumption: float)
+getOperatorId(): int
+getConsumption(): float
+getDate(): long
+getMeterId(): int

4.3.1.3 Back-Office application

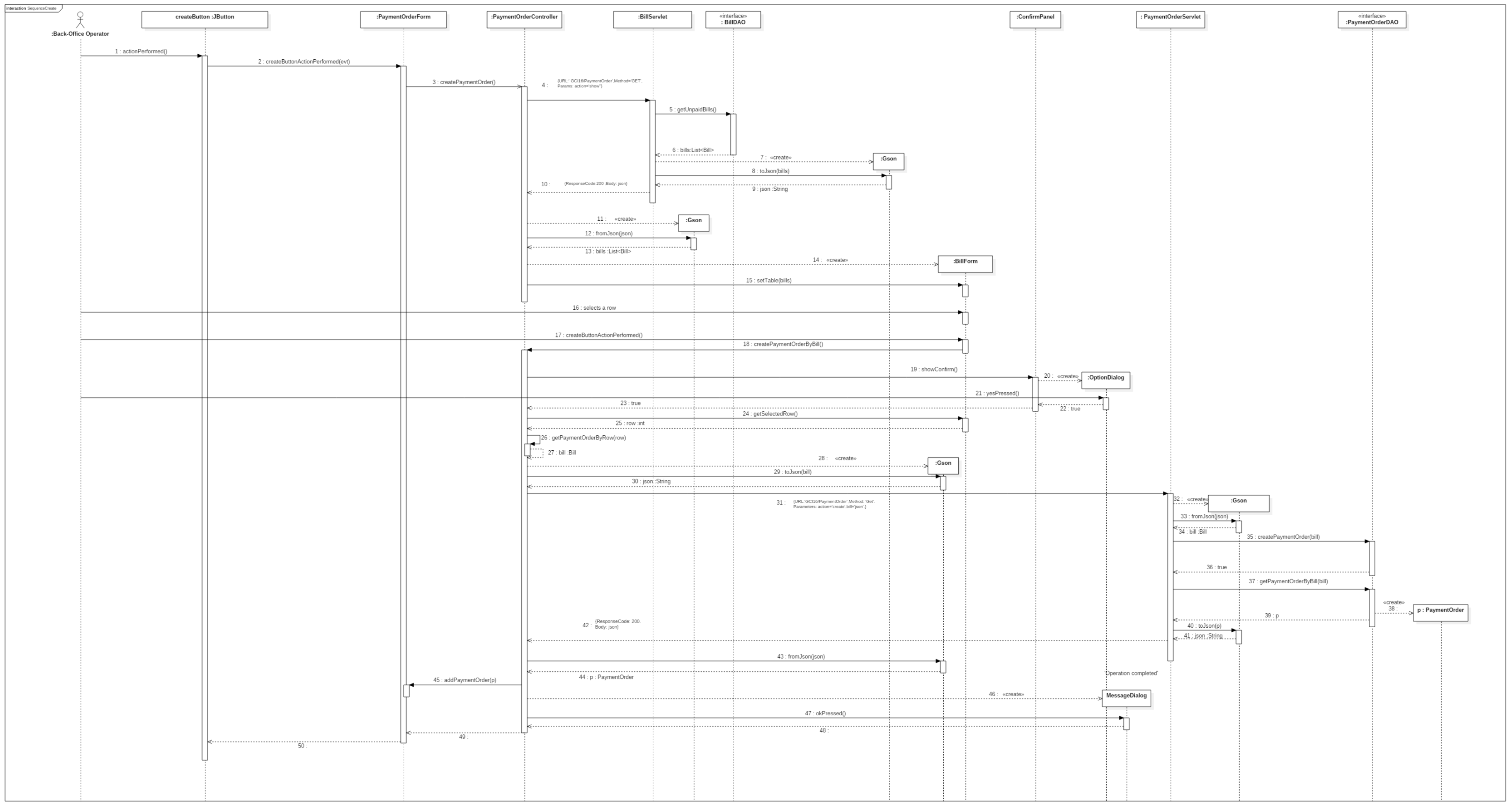

«frame»
MainForm
+MainForm(mainController: MainController)
+dispose()
-initComponents()
-PaymentOrdersButtonActionPerformed(evt: ActionEvent)
-logoutButtonActionPerformed(evt: ActionEvent)
-mainPage
-mainController
Gson
+toJson(src: Object): String
+fromJson(json: String): T
PDFGenerator
+generate(paym: PaymentOrder): boolean
«uses»
PaymentOrder
-id: int
-protocol: Integer
-amount: double
+PaymentOrder(id: int, protocol: Integer, status: PaymentOrder.Status, bill: Bill, amount: double)
+isNextStatus(newStatus: PaymentOrder.Status): boolean
+getBill(): Bill
+getId(): int
+getProtocol(): int
+getStatus(): PaymentOrder.Status
+getTrimester(): int
+getYear(): int
+getAmount(): double
+setStatus(status: PaymentOrder.Status)
+setProtocol(protocol: Integer)
+getDebtor(): String
-paymOrdList
0..*
«uses»
-bill
I metodi che hanno come parametri di tipo ActionEvent o KeyEvent sono autogenerati da Netbeans
MainController
-session: String
+MainController(session: String)
+start()
+managePaymentOrders()
+logout()
«uses»
«start»
«start»
PaymentOrderController
-session: String
+PaymentOrderController(session: String)
+start()
+createPaymentOrder()
+createPaymentOrderByBill()
+deletePaymentOrder()
+saveAsSuspendedPaymentOrder()
+saveAsPaidPaymentOrder()
+saveAsNotPertinentPaymentOrder()
+issuePaymentOrder()
+getPaymentOrderByRow(row: int): null
+reissuePaymentOrder()
-billList
0..*
Bill
-id: int
-cost: double
-year: int
-trimester: int
+Bill(customer: Customer, cost: double, year: int, trimester: int)
+Bill(id: int, customer: Customer, cost: double, year: int, trimester: int)
+getId(): int
+getCustomer(): Customer
+getTrimester(): int
+getYear(): int
+getCost(): double
+getName(): String
+getSurname(): String
«uses»
«start»
«start»
-paymOrdController
-paymOrdController
BackOfficeLoginController
+start()
+login(user: String, pass: String)
-billFrame
«frame»
BillsForm
+BillForm(paymOrdController: PaymentOrderController)
+dispose()
+getTableSelectedRow(): int
-addBill(b: Bill)
+setTable(list: List<Bill>)
-createPoButtonActionPerformed(evt: ActionEvent)
-customer
Customer
-name: String
-surname: String
+Customer(name: String, surname: String)
+getName(): String
+getSurname(): String
-loginController
-paymentOrderFrame
-login
«frame»
BackOfficeLoginForm
+BackOfficeLoginForm(loginController: BackOfficeLoginController)
+dispose()
-initComponents()
-loginButtonActionPerformed(evt: ActionEvent)
«frame»
PaymentOrderForm
+PaymentOrderForm(paymOrdController: PaymentOrderController)
+dispose()
+addPaymentOrder(p: PaymentOrder)
+removePaymentOrderByRow(row: int)
+getTableSelectedRow(): int
+setProtocolNumberByRow(row: int, int protocol)
+clearSelectionTable()
+setTable(list: List<PaymentOrder>)
-createButtonActionPerformed(evt: ActionEvent)
-deleteButtonActionPerformed(evt: ActionEvent)
-saveAsSuspendedActionPerformed(evt: ActionEvent)
-saveAsPaidButtonActionPerformed(evt: ActionEvent)
-saveAsNotPertinentButtonActionPerformed(evt: ActionEvent)
-reissueButtonActionPerformed(evt: ActionEvent)
-issueButtonActionPerformed(evt: ActionEvent)
-filterButtonActionPerformed(evt: ActionEvent)
-protocolTextKeyTyped(evt: KeyEvent)
-clearFilterButtonActionPerformed(evt: ActionEvent)
+setPaymentOrderStatus(row: int, status: PaymentOrder.Status)
+setProtocolNumberByRow(row: int, protocol: int)

4.3.1.4 Mobile application

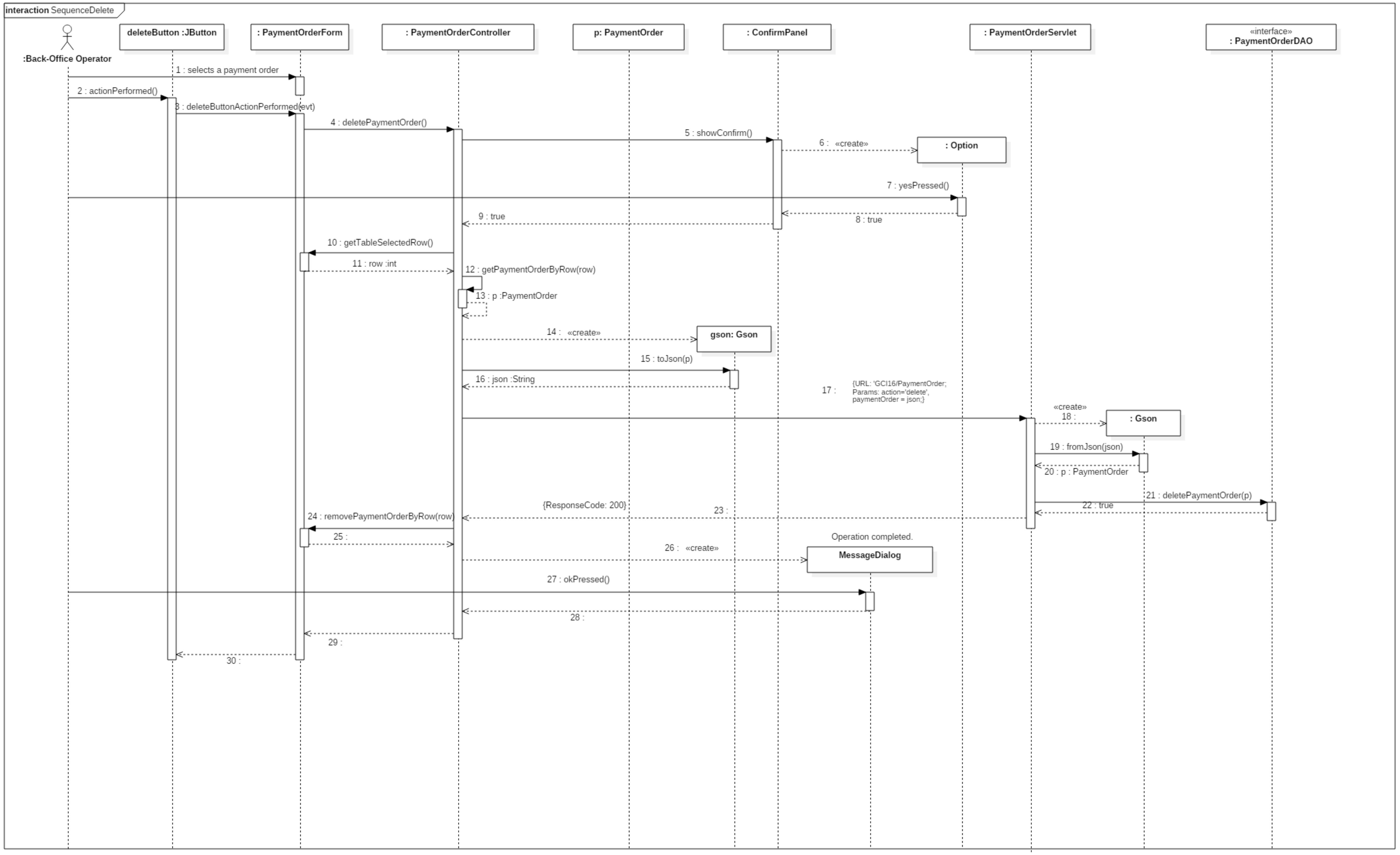


4.3.2 Sequence diagrams

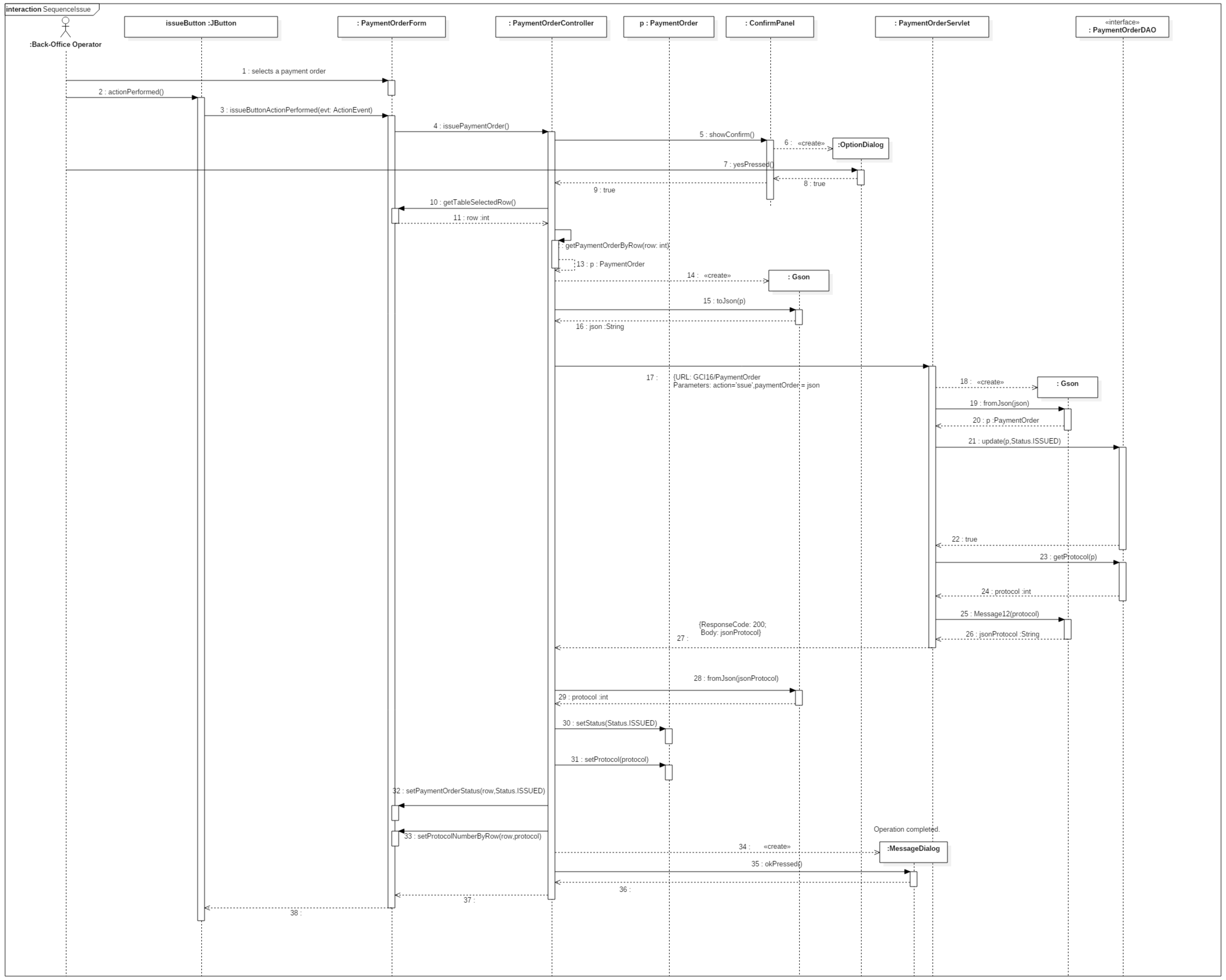
4.3.2.1 Create payment order



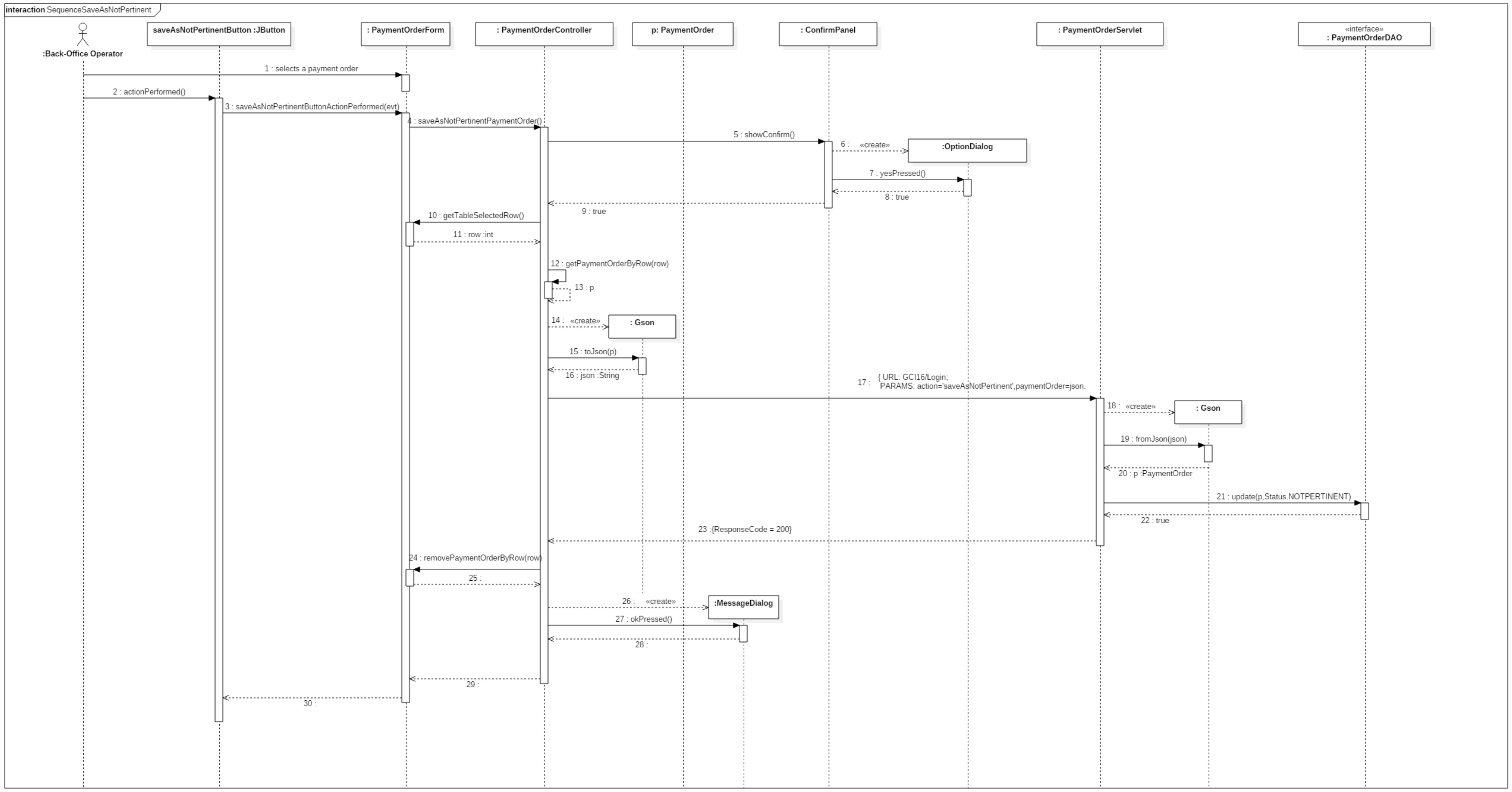
4.3.2.2 Delete payment order



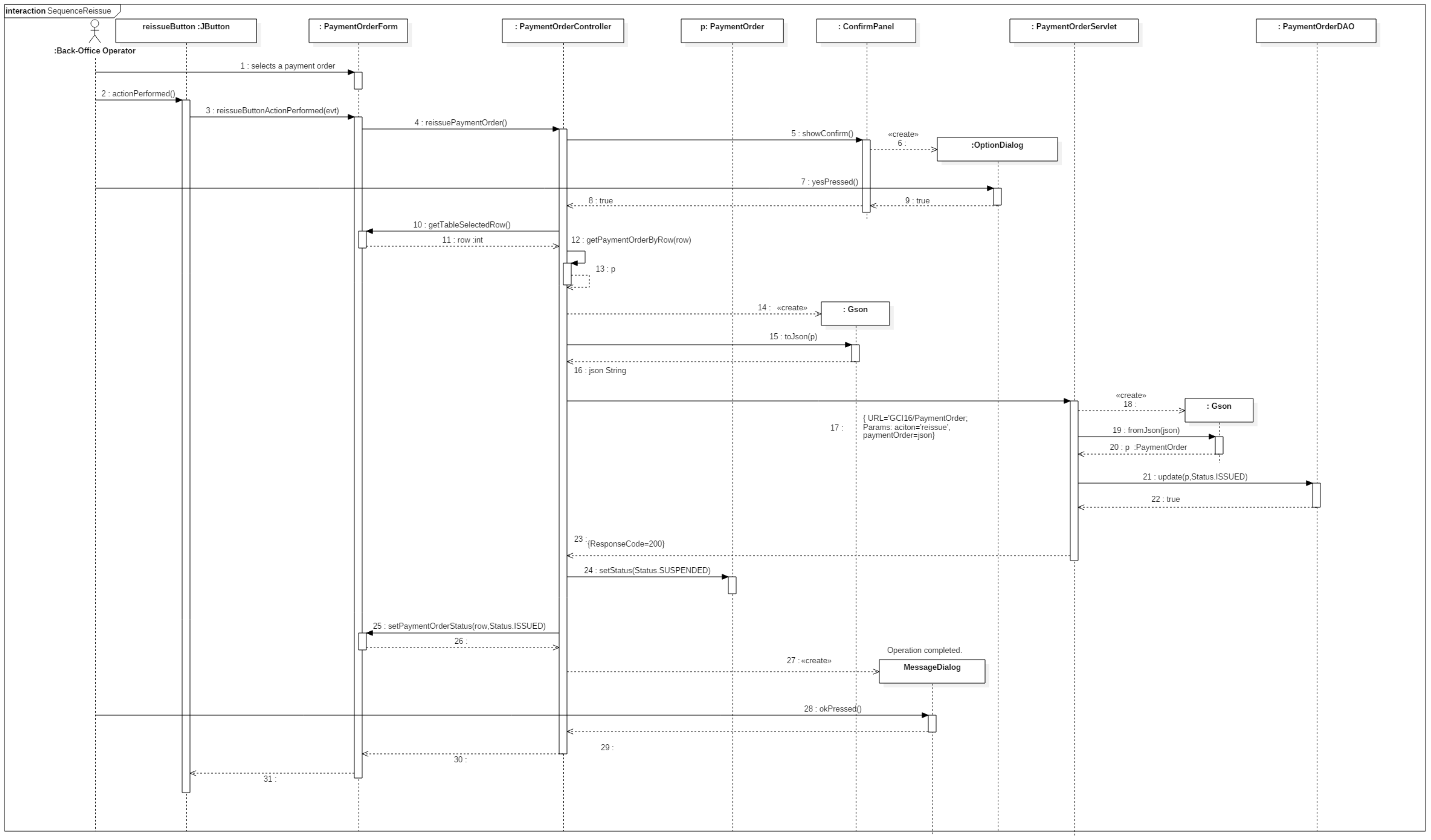
4.3.2.3 Issue payment order



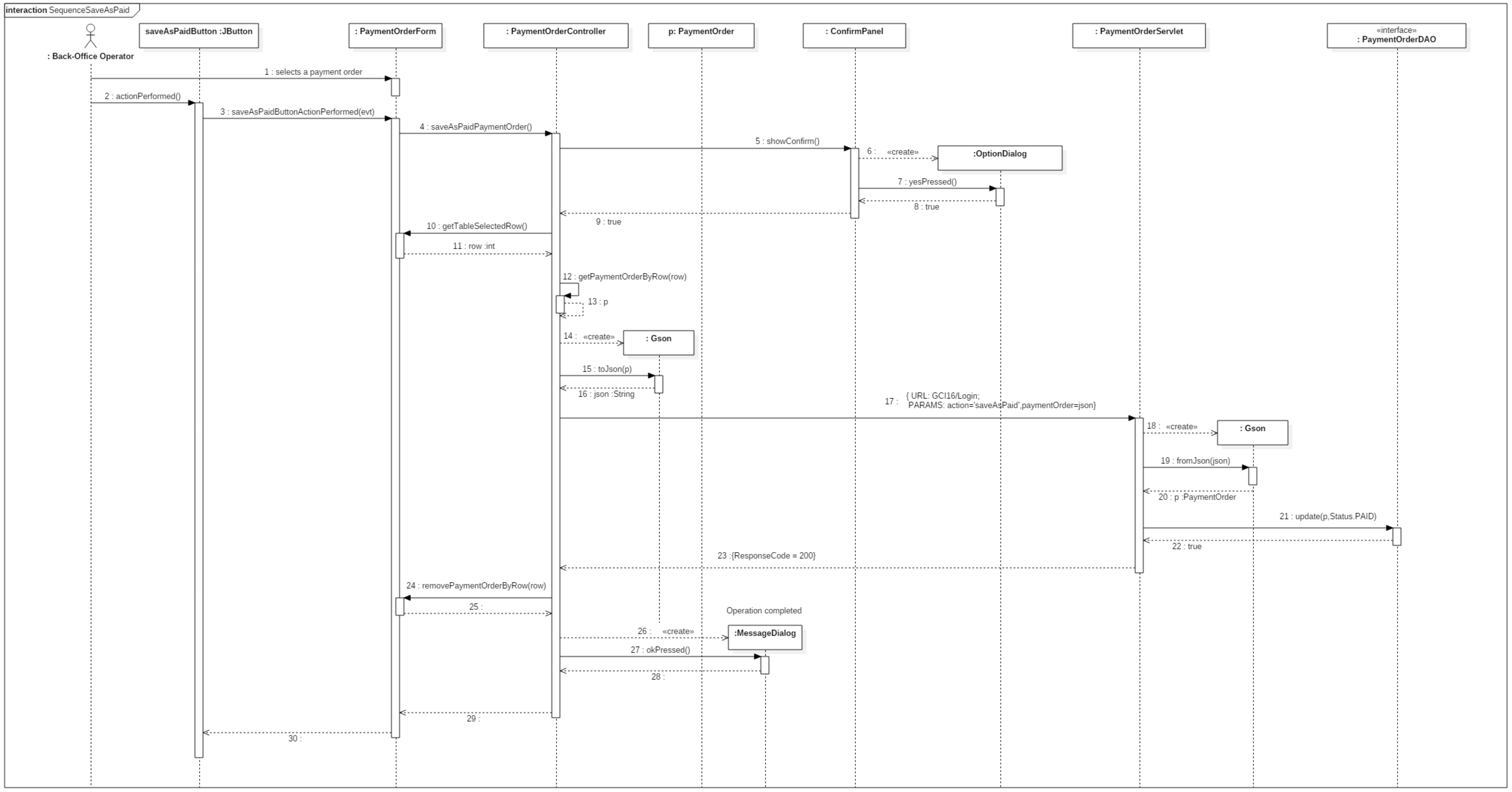
4.3.2.4 Save as not pertinent payment order



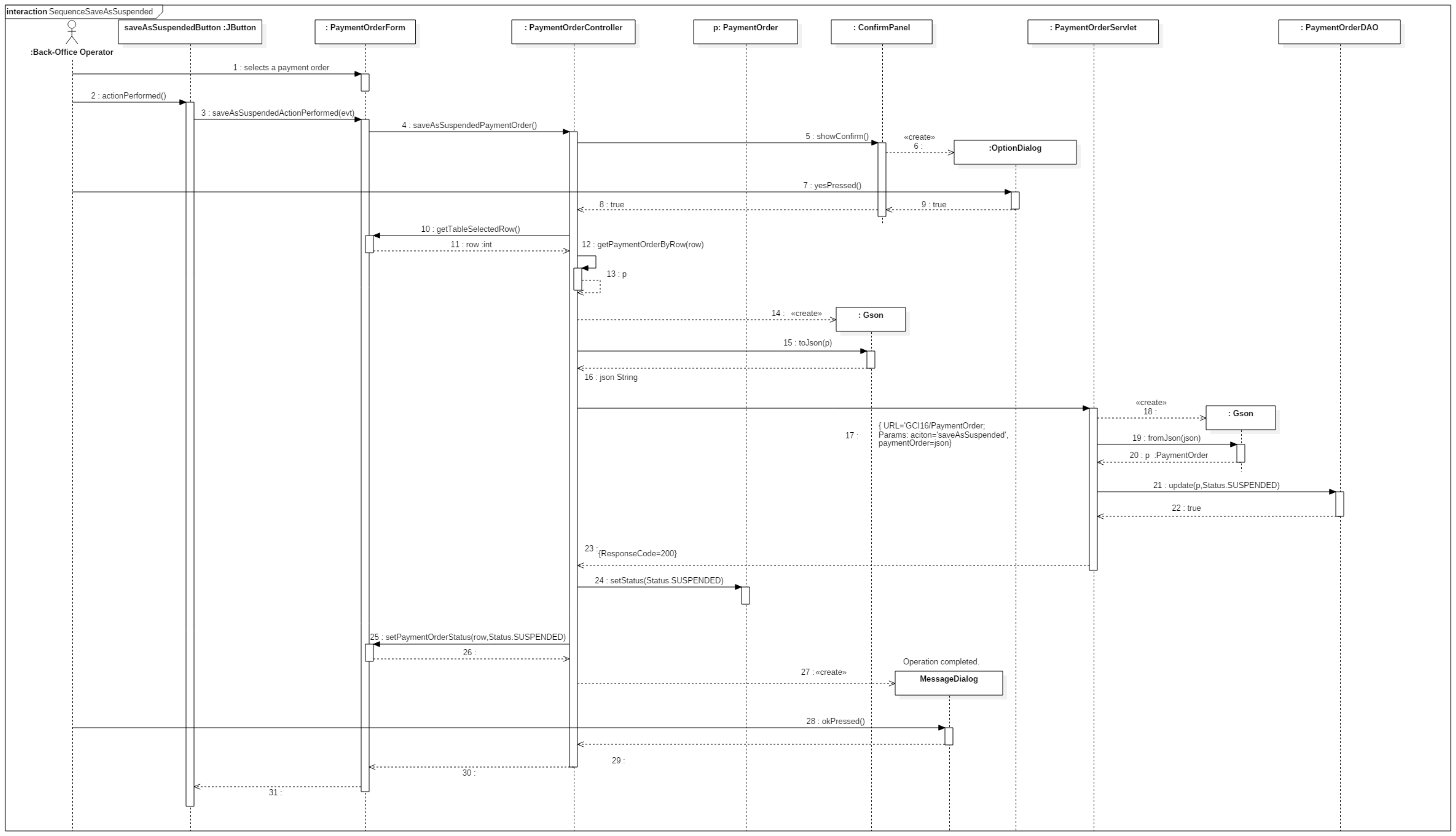
4.3.2.5 Reissue payment order



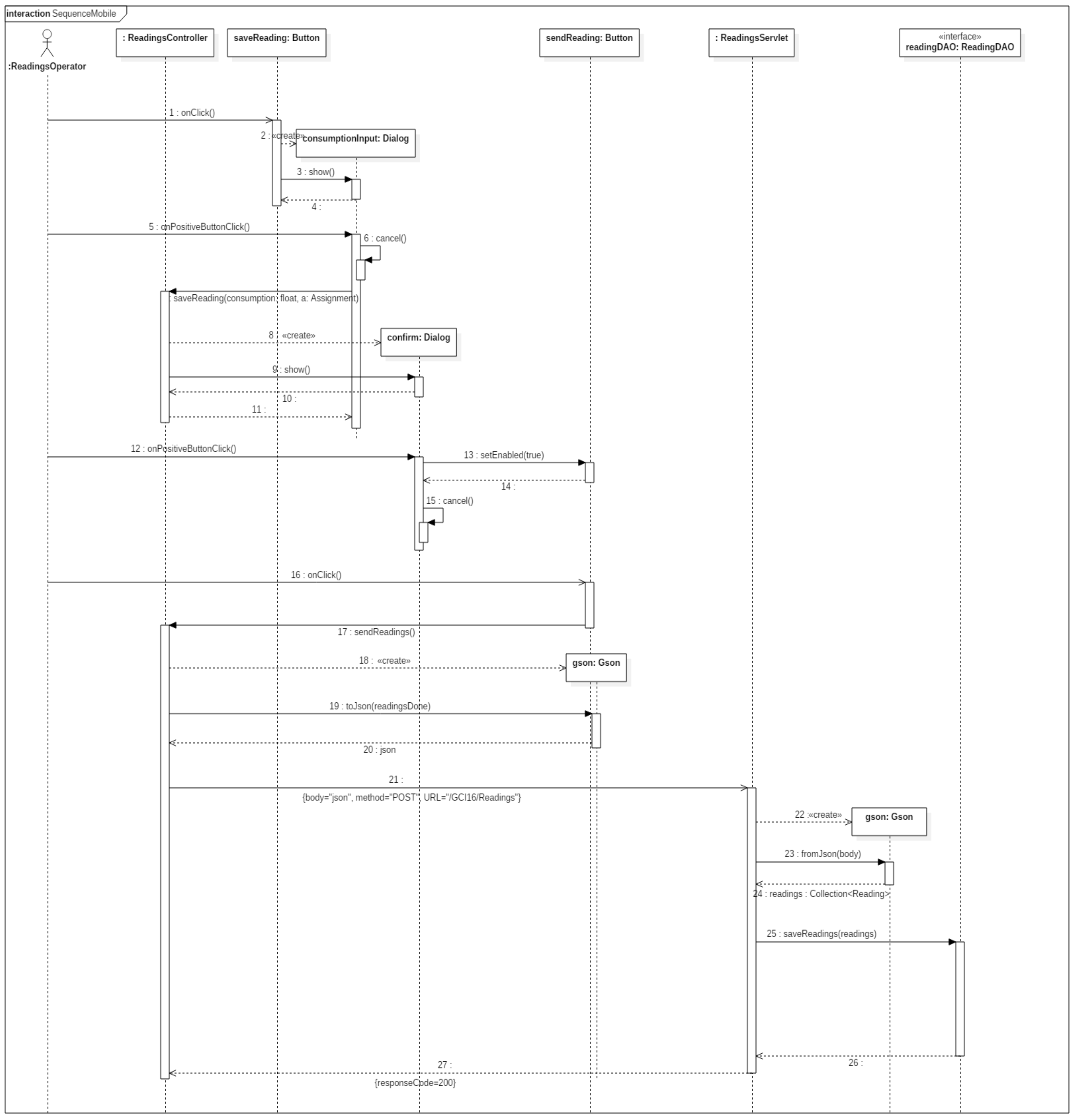
4.3.2.6 Save as paid payment order



4.3.2.7 Save as suspended payment order



4.3.2.8 Send readings



4.4 CRC cards

4.4.1 Server

Class Name	BackOfficeLoginServlet
Superclass	HttpServlet
Subclasses	

Responsabilities	**Collaborators**
Provide an access token for a Back-Office operator who submits correct credentials	OperatorDAO, Operator

Class Name	BillDAO
Superclass	
Subclasses	

Responsabilities	**Collaborators**
Retrieve the bill unpaid for three months from the data source.	Bill, Database

Class Name	BillServlet
Superclass	HttpServlet
Subclasses	

Responsabilities	**Collaborators**
Provide an operator with the list of all the bills not paid for three months.	BillDAO, Bill

Class Name	PaymentOrderDAO
Superclass	
Subclasses	

Responsabilities	**Collaborators**
Create a new payment order in the data source.	PaymentOrder, Database
Delete a payment order from the data source.	PaymentOrder, Database
Update the status of a payment order in the data source.	PaymentOrder, Database
Retrieve payment orders data from the data source.	PaymentOrder, Database

Class Name	PaymentOrderServlet
Superclass	HttpServlet
Subclasses	

Responsabilities	**Collaborators**
Create a new payment order in the data source.	PaymentOrderDAO, PaymentOrder
Delete a payment order from the data source.	PaymentOrderDAO, PaymentOrder
Save a payment order as suspended in the data source.	PaymentOrderDAO, PaymentOrder
Save a payment order as paid in the data source.	PaymentOrderDAO, PaymentOrder
Save a payment order as not pertinent in the data source.	PaymentOrderDAO, PaymentOrder
Issue a payment order in the data source.	PaymentOrderDAO, PaymentOrder
Reissue a suspended payment order in the source.	PaymentOrderDAO, PaymentOrder

4.4.2 Back-Office Application

Class Name	BackOfficeLoginController
Superclass	
Subclasses	

Responsabilities	**Collaborators**
Let a Back-Office operator log in the system.	BackOfficeLoginForm, BackOfficeLoginServlet

Class Name	Bill
Superclass	
Subclasses	

Responsabilities	**Collaborators**
Represent the bill for a trimester.	

Class Name	BillForm
Superclass	JFrame
Subclasses	

Responsabilities	**Collaborators**
Show a table in which each row represents an unpaid bill.	PaymentOrderController
Allow to select a bill from the bill's table, of which a payment order can now be created.	
Give the row selected number of the bills' table.	

Class Name	Customer
Superclass	
Subclasses	

Responsabilities	**Collaborators**
Represent a customer of the society.	

Class Name	MainController
Superclass	
Subclasses	

Responsabilities	**Collaborators**
Address the user to the macro-functionalities of the system.	

Class Name	PaymentOrder
Superclass	
Subclasses	

Responsabilities	**Collaborators**
Represent a payment order due to a not payed bill.	

Class Name	PaymentOrderController
Superclass	
Subclasses	

Responsabilities	**Collaborators**
Create a new payment order.	PaymentOrderForm, PaymentOrder, BillForm, Bill, PaymentOrderServlet
Delete a payment order.	PaymentOrderForm, PaymentOrder, PaymentOrderServlet
Save a payment order as suspended.	PaymentOrderForm, PaymentOrder, PaymentOrderServlet
Save a payment order as paid.	PaymentOrderForm, PaymentOrder, PaymentOrderServlet
Save a payment order as not pertinent.	PaymentOrderForm, PaymentOrder, PaymentOrderServlet
Issue a payment order.	PaymentOrderForm, PaymentOrder, PDFGenerator, PaymentOrderServlet
Reissue a suspended payment order.	PaymentOrderForm, PaymentOrder, PaymentOrderServlet

Class Name	PaymentOrderForm
Superclass	JFrame
Subclasses	

Responsabilities	**Collaborators**
Show payment orders’ table in which each row represents a payment order.	PaymentOrderController
Allow interaction with payment orders’ table.	
Give the row selected number of the payment orders’ table.	
Filter payment orders relatively to their attributes.	

4.4.3 Mobile Application

Class Name	Assignment
Superclass	
Subclasses	

Responsibilities	**Collaborators**
Represent the task of performing a reading of a meter.	

Class Name	AssignmentServlet
Superclass	HttpServlet
Subclasses	

Responsibilities	**Collaborators**
Provide an operator with the list of his assignments.	Assignment, AssignmentDAO, Gson

Class Name	LoginController
Superclass	AppCompatActivity
Subclasses	

Responsibilities	**Collaborators**
Let the operator login from the mobile application.	

Class Name	Reading
Superclass	
Subclasses	

Responsibilities	**Collaborators**
Represent the reading of the water consumption reported on a meter.	

Class Name	ReadingsController
Superclass	AppCompatActivity

Subclasses	

Responsibilities	Collaborators
Let the user save the reading consumption reported on a meter.	Assignment, Reading, Gson
Update user's list of assignments.	Assignment, Gson
Send the readings done to a remote server.	Reading, Gson

Class Name	ReadingsServlet
Superclass	HttpServlet
Subclasses	

Responsibilities	Collaborators
Save into the database the readings performed by a Readings Operator.	Reading, ReadingDAO, Gson

5 Testing documentation

5.1 System Testing

As agreed with the customer we have created a System Testing plan that tests each User Interface behaviour and each Use Case defined in the Requirements section.

The plan has been created using **WECT** (Weak Equivalence Class Testing).

5.1.1 Back-Office Application

Test ID	1		
Test Name	Back Office Login		
Test Description	Tests the Back Office application’s login form validity.		
Input	**System status**	**Oracle**	**Output**
The user enters correct username and password	The server is reachable	The application shows the main screen of the application	
The user enters a wrong combination of username and/or password	The server is reachable	The application shows an error message telling that he entered bad credentials	
The user leaves a blank username and/or password field	The server is reachable	The application shows an error message telling that one of the two fields is empty	
The user doesn’t leave empty fields	The server is not reachable	The application shows an error message telling that the server is not available	
The user presses the “Close window” button		The application closes	

Test ID	2		
Test Name	Payment Order Management		
Test Description	Tests the validity of the screen that lets the user manage the payment orders.		
Input	**System status**	**Oracle**	**Output**
The user clicks on a row whose status is “NOTIFIED”		Only “Create”, “Save as suspended” and “Save as paid” button are enabled	
The user clicks on a row whose status is “NOTISSUED”		Only “Create”, “Issue” and “Delete” button are enabled	
The user clicks on a row whose status is “SUSPENDED”		Only “Create”, “Reissue” and “Save as not pertinent” button are enabled	
The user presses “Save as suspended” button and confirms the operation	The server is reachable and the operation is successful	The status of the previously selected row changes to “SUSPENDED” and all buttons (“Create” excluded) are disabled	
The user presses “Save as paid” button and confirms the operation	The server is reachable and the operation is successful	The previously selected row is removed and all buttons (“Create” excluded) are disabled	
The user presses “Issue” button and confirms the operation	The server is reachable and the operation is successful	The status of the previously selected row changes to “ISSUED” and all buttons (“Create” excluded) are disabled	
The user presses “Delete” button and confirms the operation	The server is reachable and the operation is successful	The previously selected row is removed and all buttons (“Create” excluded) are disabled	
The user presses “Reissue” button and confirms the operation	The server is reachable and the operation is successful	The status of the previously selected row changes to “ISSUED” and all buttons (“Create” excluded) are disabled	
The user fills some filtering fields		Only the rows that satisfy the filtering criteria are left shown in the table	
The user clicks on a operation button(“Create” excluded) and confirms it	The server is not reachable	The application shows an error message	
The user clicks on a operation button(“Create” excluded) and confirms it	The server is reachable but the access token has expired	The application shows an error message and then the login screen	
The user presses the “Close window” button		The application shows the home screen	

Test ID	3		
Test Name	Bill form		
Test Description	Tests the frame where the user can choose a bill to create a payment order		
Input	**System status**	**Oracle**	**Output**
The user selects a row from the table		The “Create payment order” button is enabled	
The user presses “Create payment order” button	The server is not reachable	The application shows an error message	
The user presses “Create payment order” button	The server is reachable and the server-side operation is successful	The application shows the Payment Order management frame with the new payment order	
The user presses “Create payment order” button	The server is reachable but the server-side operation is not successful	The application shows an error message	
The user presses “Create payment order” button	The server is reachable but the access token has expired	The application shows an error message and then shows the login screen	
The user presses the “Close window” button		The application shows the Payment Order management frame	

5.1.2 Mobile Application

Test ID	4		
Test Name	Readings Operator Login		
Test Description	Tests the Readings Operator mobile application’s login form validity		
Input	**System status**	**Oracle**	**Output**
The user enters correct operator id and password	The server is reachable	The application shows the main screen of the application	
The user enters a wrong combination of operator id and/or password	The server is reachable	The application shows an error message telling that he entered bad credentials	
The user leaves a blank operator id and/or password field		“Login” button is disabled	
The user doesn’t leave empty fields	The server is not reachable	The application shows an error message telling that the server is not available	
The user presses the back button		The application closes	

Test ID	5		
Test Name	Readings Operator application		
Test Description	Tests the behaviour of the mobile application for Readings Operators		
Input	**System status**	**Oracle**	**Output**
The user selects an assignment from the table		The "Save reading" button is enabled	
The user presses the menu button and then "Logout" button, and confirms the operation		The application shows the login screen.	
The user presses "Update" button	The server is reachable	The application shows in the table the assignment of the operator, except the ones already completed but not sended	
User presses "Save reading" button, enters the consumption and presses "Save"		The assignment previously selected is removed from the table and the "Send readings" button is enabled	
User presses "Send readings" button	The server is reachable and the server-side operation is successful	"Send readings" button is disabled	
The user presses "Send readings" or "Update" button	The server is not reachable	The application shows an error message	
The user presses "Send readings" or "Update" button	The server is reachable but the server-side operation fails	The application shows an error message	
The user presses "Send readings" or "Update" button	The server is reachable but the access token has expired	The application shows an error message and then the login screen	
The user presses back button		The application goes in background	

5.2 Unit Testing

We have decided to test a servlet with jUnit with the following test cases using **SECT** (Strong Equivalence Class Testing) method, in particular we have tested the *doPost* method of *ReadingsServlet*, that handles the storing of readings.

To create the stub classes we have used Mockito frameworks, which allows to easily create a class or interface instance and to define method returns

5.2.1 Parameter equivalence classes

Parameters domain	Description	Equivalence classes	Values
A		A1	Not null
		A2	Null
B		B1	Collections of Reading instances
		B2	Missing parameter in request
		B3	Well-formed JSON strings but not a collection of Reading instances
		B4	Malformed JSON strings
C		C1	TRUE
		C2	FALSE

5.2.2 Test cases

Test case	A	B	C	Response code
SE 1	A1	B1	C1	200
SE 2	A1	B1	C2	500
SE 3	A1	B2	C1	463
SE 4	A1	B2	C2	463
SE 5	A1	B3	C1	464
SE 6	A1	B3	C2	464
SE 7	A1	B4	C1	464
SE 8	A1	B4	C2	464
SE 9	A2	B1	C1	461
SE 10	A2	B1	C2	461
SE 11	A2	B2	C1	461
SE 12	A2	B2	C2	461
SE 13	A2	B3	C1	461
SE 14	A2	B3	C2	461
SE 15	A2	B4	C1	461
SE 16	A2	B4	C2	461

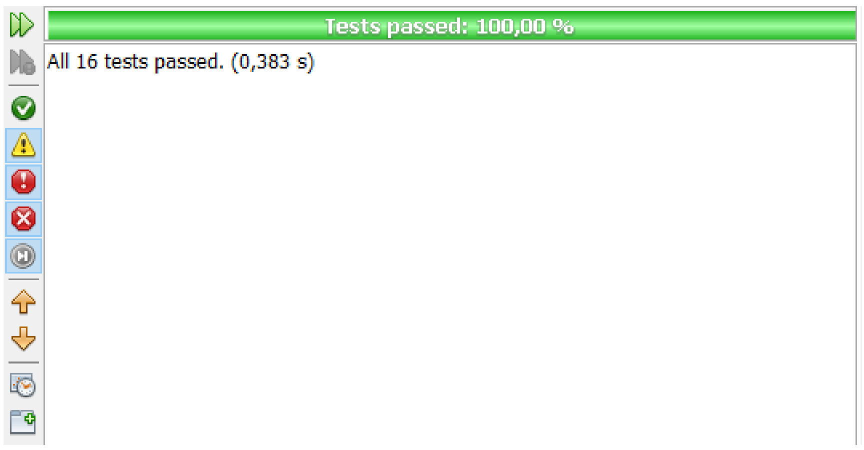
5.2.3 Code

```java
import com.google.gson.Gson;
import dao.interfaces.ReadingDAO;
import entities.Customer;
import entities.Reading;
import java.io.IOException;
import java.util.LinkedList;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import javax.servlet.http.HttpServletResponseWrapper;
import javax.servlet.http.HttpSession;
import junit.framework.Assert;
import org.junit.Before;
import org.junit.Test;
import org.mockito.Mockito;
import server.mobile.ReadingsServlet;

/**
 * Testing of doPost method using JUnit 4.9 in SECT method
 * @author GCI16_25
 */
public final class ReadingsServletTest extends Mockito{
    private final ReadingsServlet servlet = new ReadingsServlet();
    private HttpServletRequest request;
    private HttpServletResponse response;
    private ReadingDAO readingDAO;
    private HttpSession session;

    private static class HttpServletResponseForTest extends
HttpServletResponseWrapper{
        private int status = 200;
        private String message;

        public HttpServletResponseForTest() {
            super(mock(HttpServletResponse.class));
        }

        @Override
        public void setStatus(int status){
            this.status = status;
        }

        @Override
        public void sendError(int sc) throws IOException {
            setStatus(sc);
        }

        @Override
        public void sendError(int sc, String msg) throws IOException {
            sendError(sc);
            this.message = msg;
        }

        @Override
        public int getStatus() {
            return this.status;
        }
    }

    @Before
    public void prepareTest(){
        //servlet = mock(ReadingsServlet.class);
        request = mock(HttpServletRequest.class);
        response = new HttpServletResponseForTest();
        readingDAO = mock(ReadingDAO.class);
        session = mock(HttpSession.class);
        servlet.setReadingDAO(readingDAO);
    }

    /*  Test 1
        Session found, JSON readings well-formed and DAO returns true */
    @Test
    public void test_okSession_okJSON_trueDAO(){
        Gson gson = new Gson();
        Reading readingObject = new Reading(1, 1, 1);
        LinkedList<Reading> readingCollection = new LinkedList<>();
        readingCollection.add(readingObject);
        String reading = gson.toJson(readingCollection);

        when(request.getSession(false)).thenReturn(session); // Set stub session
        when(request.getParameter("readings")).thenReturn(reading); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(true); // Set stub
readings parameter
        try {
            servlet.doPost(request, response);
        } catch (IOException ex) {
            Assert.assertTrue(false);
        }
        Assert.assertEquals(200, response.getStatus());
    }

    /*  Test 2
        Session found, JSON readings well-formed and DAO returns false */
    @Test
    public void test_okSession_okJSON_falseDAO() throws Exception{
        Gson gson = new Gson();
        Reading readingObject = new Reading(1, 1, 1);
        LinkedList<Reading> readingCollection = new LinkedList<>();
        readingCollection.add(readingObject);
        String reading = gson.toJson(readingCollection);

        when(request.getSession(false)).thenReturn(session); // Set stub session
        when(request.getParameter("readings")).thenReturn(reading); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(false); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(500, response.getStatus());
    }

    /*  Test 3
        Session found, no JSON readings and DAO returns true */
    @Test
    public void test_okSession_noJSON_trueDAO() throws Exception{
        when(request.getSession(false)).thenReturn(session); // Set stub session
        when(request.getParameter("readings")).thenReturn(null); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(true); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(463, response.getStatus());
    }
    /*  Test 4
        Session found, no JSON readings and DAO returns false */
    @Test
    public void test_okSession_noJSON_falseDAO() throws Exception{
        when(request.getSession(false)).thenReturn(session); // Set stub session
        when(request.getParameter("readings")).thenReturn(null); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(false); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(463, response.getStatus());
    }

    /*  Test 5
        Session found, not reading JSON and DAO returns true */
    @Test
    public void test_okSession_notReadingJSON_trueDAO() throws Exception{
        Gson gson = new Gson();
        Customer customerObject = new Customer("carlo", "de vita");
        LinkedList<Customer> customerCollection = new LinkedList<>();
        customerCollection.add(customerObject);
        String customer = gson.toJson(customerCollection);

        when(request.getSession(false)).thenReturn(session); // Set stub session
        when(request.getParameter("readings")).thenReturn(customer); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(true); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(464, response.getStatus());
    }

    /*  Test 6
        Session found, not reading JSON and DAO returns false */
    @Test
    public void test_okSession_notReadingJSON_falseDAO() throws Exception{
        Gson gson = new Gson();
        Customer customerObject = new Customer("carlo", "de vita");
        LinkedList<Customer> customerCollection = new LinkedList<>();
        customerCollection.add(customerObject);
        String customer = gson.toJson(customerCollection);

        when(request.getSession(false)).thenReturn(session); // Set stub session
        when(request.getParameter("readings")).thenReturn(customer); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(false); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(464, response.getStatus());
    }

    /*  Test 7
        Session found, JSON readings not well-formed and DAO returns true */
    @Test
    public void test_okSession_notWellFormedJSON_trueDAO() throws Exception{

        when(request.getSession(false)).thenReturn(session); // Set stub session
        when(request.getParameter("readings")).thenReturn("Provaaa"); // Set
stub readings parameter
```

```
        when(readingDAO.saveReadings(any())).thenReturn(true); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(464, response.getStatus());
    }

    /*  Test 8
        Session found, JSON readings not well-formed and DAO returns false */
    @Test
    public void test_okSession_notWellFormedJSON_falseDAO() throws Exception{

        when(request.getSession(false)).thenReturn(session); // Set stub session
        when(request.getParameter("readings")).thenReturn("Provaaa"); // Set
stub readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(false); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(464, response.getStatus());
    }

    /*  Test 9
        Session does not exist, JSON readings well-formed and DAO returns true
*/
    @Test
    public void test_noSession_okJSON_trueDAO() throws Exception{
        Gson gson = new Gson();
        Reading readingObject = new Reading(1, 1, 1);
        LinkedList<Reading> readingCollection = new LinkedList<>();
        readingCollection.add(readingObject);
        String reading = gson.toJson(readingCollection);

        when(request.getSession(false)).thenReturn(null); // Set stub session
        when(request.getParameter("readings")).thenReturn(reading); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(true); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(462, response.getStatus());
    }

    /*  Test 10
        Session does not exist, JSON readings well-formed and DAO returns false
*/
    @Test
    public void test_noSession_okJSON_falseDAO() throws Exception{
        Gson gson = new Gson();
        Reading readingObject = new Reading(1, 1, 1);
        LinkedList<Reading> readingCollection = new LinkedList<>();
        readingCollection.add(readingObject);
        String reading = gson.toJson(readingCollection);

        when(request.getSession(false)).thenReturn(null); // Set stub session
        when(request.getParameter("readings")).thenReturn(reading); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(false); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(462, response.getStatus());
    }
    /*  Test 11
        Session does not exist, no JSON readings and DAO returns true */
    @Test
    public void test_noSession_noJSON_trueDAO() throws Exception{
        when(request.getSession(false)).thenReturn(null); // Set stub session
        when(request.getParameter("readings")).thenReturn(null); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(true); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(462, response.getStatus());
    }

    /*  Test 12
        Session does not exist, no JSON readings and DAO returns false */
    @Test
    public void test_noSession_noJSON_falseDAO() throws Exception{
        when(request.getSession(false)).thenReturn(null); // Set stub session
        when(request.getParameter("readings")).thenReturn(null); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(false); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(462, response.getStatus());
    }

    /*  Test 13
        Session does not exist, not reading JSON and DAO returns true */
    @Test
    public void test_noSession_notReadingJSON_trueDAO() throws Exception{
        Gson gson = new Gson();
        Customer customerObject = new Customer("carlo", "de vita");
        LinkedList<Customer> customerCollection = new LinkedList<>();
        customerCollection.add(customerObject);
        String customer = gson.toJson(customerCollection);

        when(request.getSession(false)).thenReturn(null); // Set stub session
        when(request.getParameter("readings")).thenReturn(customer); // Set stub
readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(true); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(462, response.getStatus());
    }

    /*  Test 14
        Session does not exist, not reading JSON and DAO returns false */
    @Test
    public void test_noSession_notReadingJSON_falseDAO() throws Exception{
        Gson gson = new Gson();
        Customer customerObject = new Customer("carlo", "de vita");
        LinkedList<Customer> customerCollection = new LinkedList<>();
        customerCollection.add(customerObject);
        String customer = gson.toJson(customerCollection);

        when(request.getSession(false)).thenReturn(null); // Set stub session
        when(request.getParameter("readings")).thenReturn(customer); // Set stub
readings parameter
```

```
        when(readingDAO.saveReadings(any())).thenReturn(false); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(462, response.getStatus());
    }

    /*  Test 15
        Session does not exist, JSON readings not well-formed and DAO returns
true */
    @Test
    public void test_noSession_notWellFormedJSON_trueDAO() throws Exception{

        when(request.getSession(false)).thenReturn(null); // Set stub session
        when(request.getParameter("readings")).thenReturn("Provaaa"); // Set
stub readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(true); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(462, response.getStatus());
    }

    /*  Test 16
        Session does not exist, JSON readings not well-formed and DAO returns
false */
    @Test
    public void test_noSession_notWellFormedJSON_falseDAO() throws Exception{

        when(request.getSession(false)).thenReturn(null); // Set stub session
        when(request.getParameter("readings")).thenReturn("Provaaa"); // Set
stub readings parameter
        when(readingDAO.saveReadings(any())).thenReturn(false); // Set stub
readings parameter

        servlet.doPost(request, response);
        Assert.assertEquals(462, response.getStatus());
    }
}
```

5.2.4 jUnit test output



```
Tests passed: 100,00 %
All 16 tests passed. (0,383 s)
```

6 Glossary (A-Z)

Name	Description
Assignment	A task for an operator.
Back Office Operator	User of desktop application, his goal is to handle the entire payment order management system.
Issue	Render a payment order effective. After issuing a payment order, it must be paid by the debtor.
Not pertinent	If the debtor won the legal case, the payment order would be archived. The debtor won't have to pay the payment order anymore.
Payment order	Document which requires the debtor to pay within a defined deadline.
Protocol number	Every issued payment order is labelled by an index, a protocol number, which is considered a unique identifier.
Reading	Reading of water consumption reported on the meter.
Readings Operator	An operator whose task is to perform the reading of water consumption from a meter.
Suspend	A payment order can be suspended in presence of a legal case.