Part A – System Requirement Specification

R1		The software should provide facility for user to record their expenses or incomes (**AKA, Transaction**). These transactions can be either one-off or recurrence transaction. The software system should provide facility to record both type of transaction in convenience manner. The general details related to a transaction like date and time, the amount, payee and payer should be recorded. There should a separate form in order to record a new transaction. User should be able to specify a particular transaction is either income or an expense.	
	R1.1	The one-off transaction is a particular distinct expense or an income of a particular day. User should be able to give a title or a name, specify the amount, select the date optionally and save the transaction. There should be a date field which is optional for the user when recording one-off transaction. If user does not specify the date field when the transaction is saved, it will be recorded against the current day. Or else, the transaction will be record against the specified date. Having input field to add a comment will be useful for the user to add some additional notes related to transaction. One-off transaction can even be created for past days as well.	
	R1.2	The software should further provide facility to save recurrence expenses of the user. Once user has created a recurrence expense, that particular expense will be counted to the expense of the corresponding futures days until the expense is deleted or it is expired. There can be daily, weekly, monthly or yearly expenses for the user. When creating recurrence expense, user should be able to define two date fields as 'Effective from Date' and 'Effective to Date'. Both these fields can be optional for user. The current date should be populated for the 'Effective from Date' by default. If user has not specified 'Effective to Date', it should be populated by the system based on the selected 'Frequency' of the expense. Recurring expenses can even be created from past days. ▪ Daily Event - 'Effective to Date' is one year from the current day ▪ Weekly Event- 'Effective to Date' is one year from the current day ▪ Monthly Event- 'Effective to Date' is one year from the current day ▪ Yearly Event- 'Effective to Date' is 10 year from the current day	
		R1.2.1	When recording weekly recurrence expense, user should be able to specify the day of the week. It can be either as in number format from 1 to 7 or a selection from Sunday to Saturday.
		R1.2.2	When recording monthly recurrence expense, user should be able to specify the day of the month as in number format from 1 to 31st or like 'First-Sunday', 'Second-Wednesday' etc.

		R1.2.3	Similarly, as above two, when recording yearly expense, user should be able to specify the month of the year and the day of the month.
R2	The software system should provide ability to update a selected transaction.		
R3	The software should provide facility to view incomes of a particular week. This should clearly show the incomes of each day of the week with enough and possible additional details like comments, title and payer etc. User should be able to get a printout of the report.		
R4	Software should provide facility to search and list down the expenses for a given criteria like selected date or date range, expense type, payer or payee. User should be able to generate reports using these data and further, if user want to get a printout of it. The software itself should provide the print functionality.		
R5	The software should provide facility to delete transactions. When deleting a transaction, a confirmation to delete the transaction should be taken from the user by the system.		
R6	The software should provide facility to view expenses of a particular week. This should clearly show the expenses of each day of the week with enough and possible additional details like comments, title, payee and payer etc. User should be able to get a printout of this report.		
R8	Software should calculate the forecasted value for incomes and expenses on a future date by analyzing the history data available in the system database. User should be able to view these forecasted values for a given date.		
R7	Software should provide time management functionality by allowing user to record their day to day or scheduled tasks or events. These events can be appointments or tasks. The general details related to an event like date, start time, end time, name and comment should be recorded. There should a separate form in order to record a new event. There are two types of events which one-off events and recurring events. User should be able to specify a particular event is either one-off or recurrence.		
	R7.1	The one-off events happened just a once on a particular day. User should be able to add a title or a name, date on which the event happens, start time, end time and then save the event. The date field should be mandatory when saving one-off event, and it should be current or future date when creating the event. Having input field to add a comment will also be useful for the user.	
	R7.2	The software should further provide facility to save recurrence events for the user. When creating recurrence event, user should be able to define an expire date on which this particular recurrence event expires. By default, the 'Start Date' will be taken as the date on which the recurrence event is created within the system. If user has not specified 'Expire Date', by default, the recurrence event will be created based on the selected occurrence. User should be able to create recurrence events on daily, weekly, monthly and yearly basis. ▪ Daily Event - 'Effective to Date' is one year from the current day ▪ Weekly Event- 'Effective to Date' is one year from the current day ▪ Monthly Event- 'Effective to Date' is one year from the current day ▪ Yearly Event- 'Effective to Date' is 10 year from the current day	

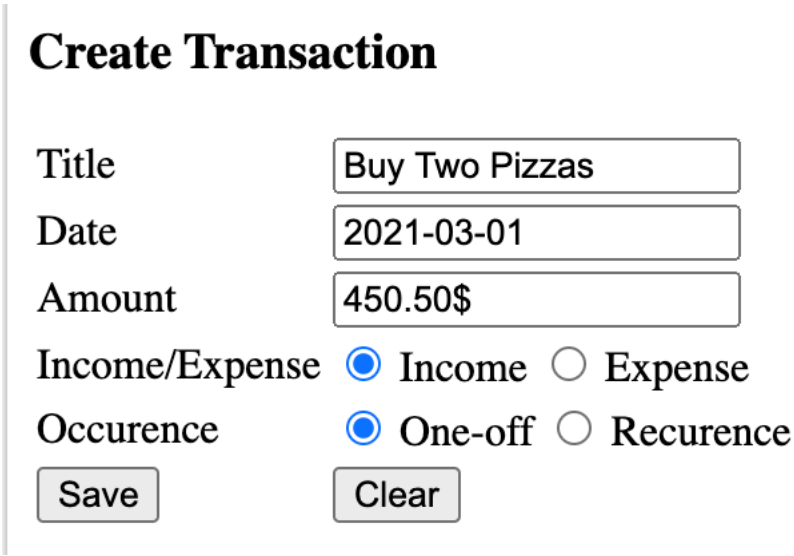
		R7.2.1	When creating weekly recurrence event, user should be able to specify the day of the week. It can be either as in number format from 1 to 7 or as a selection from Sunday to Saturday.
		R7.2.2	When recording monthly recurrence event, user should be able to specify the day of the month as in number format from 1 to 31st or like 'First-Sunday', 'Second-Wednesday' etc.
		R7.2.3	Similarly, as above two, when recording yearly event, user should be able to specify the month of the year and the day of the month.
R8	The software should provide facility to get a weekly report of events.		
R9	The software system should provide ability to update or delete a selected event.		
	The software should provide search capabilities of events, like search events by date or date range, and search events by type.		
R8	System should provide facility to manage contacts as payer or payee. This includes creating new contact, searching, updating and deleting contacts. Contact name, address and telephone number should be saved with a contact record.		

Non-Functional Requirements

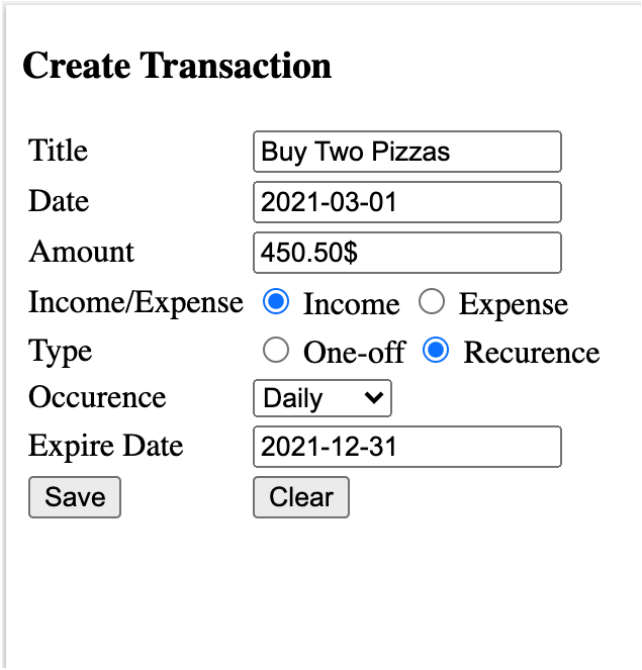
1. System should work on windows.
2. System should provide offline capabilities.
3. After reinstalling the application, the history data should be available for the same login.
4. Concurrent login should be avoided.
5. After uninstalling the application, data stored should permanently be removed. There should not be data retained in the computer.
6. No one should be able to see the data from the computer file system or from the data base. All data should be encrypted.

Screen Mockups

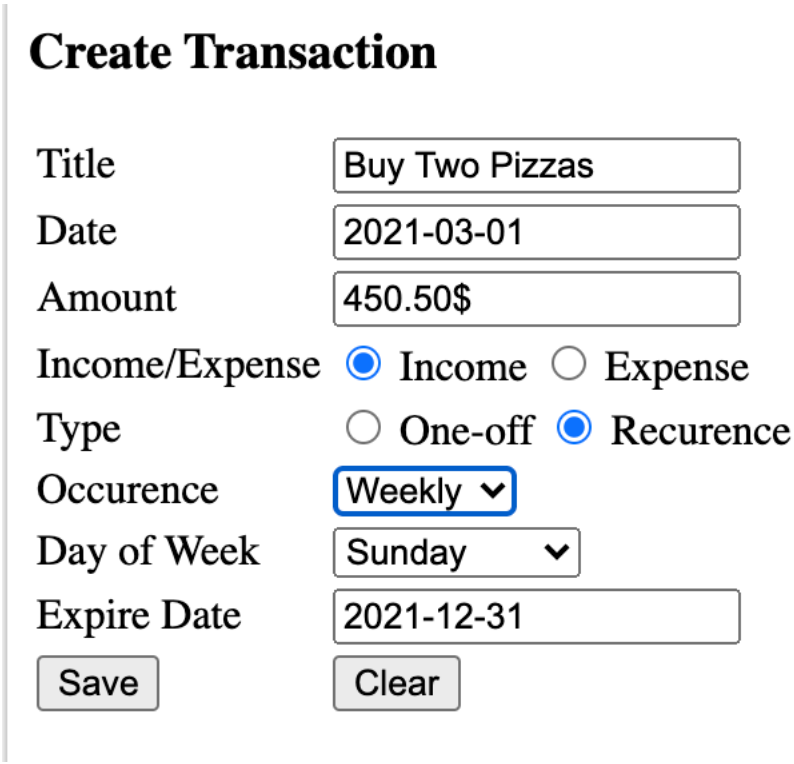
Create one-off transaction



Create daily recurrence transaction



Create weekly recurrence transaction



Create monthly recurrence transaction

Create Transaction

Title	Buy Two Pizzas
Date	2021-03-01
Amount	450.50$
Income/Expense	(•) Income ( ) Expense
Type	( ) One-off (•) Recurence
Occurence	Monthly
Day of Month	First Sunday
Expire Date	2021-12-31
Save	Clear

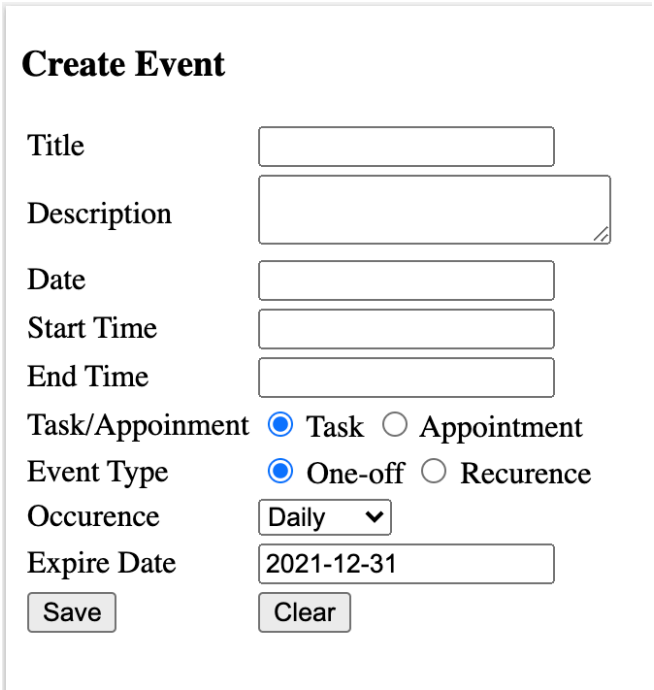
Create yearly recurrence transaction

Create Transaction

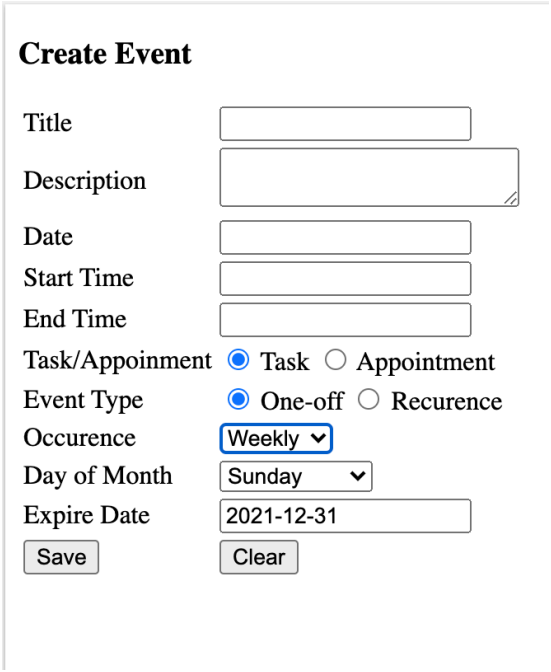
Title	Dana Pinkama
Date	2021-03-01
Amount	5000.00$
Income/Expense	( ) Income (•) Expense
Type	( ) One-off (•) Recurence
Occurence	Yearly
Day of Month	May First Sunday
Expire Date	2021-12-31
Save	Clear

Create one-off event

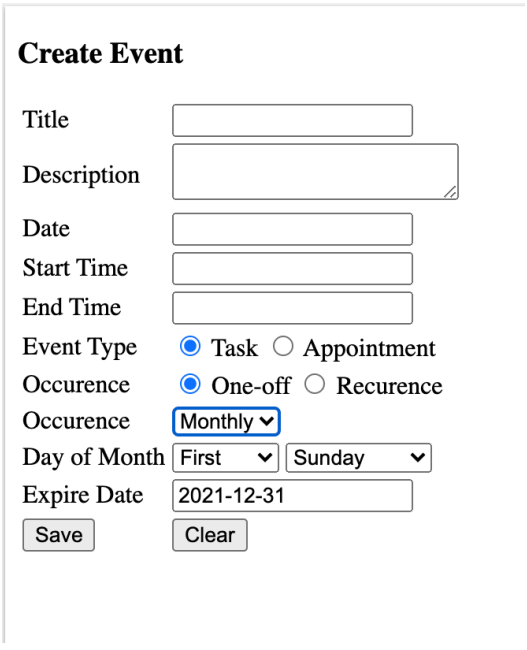
Create Daily Recurrence Event



Create Weekly Recurrence Event

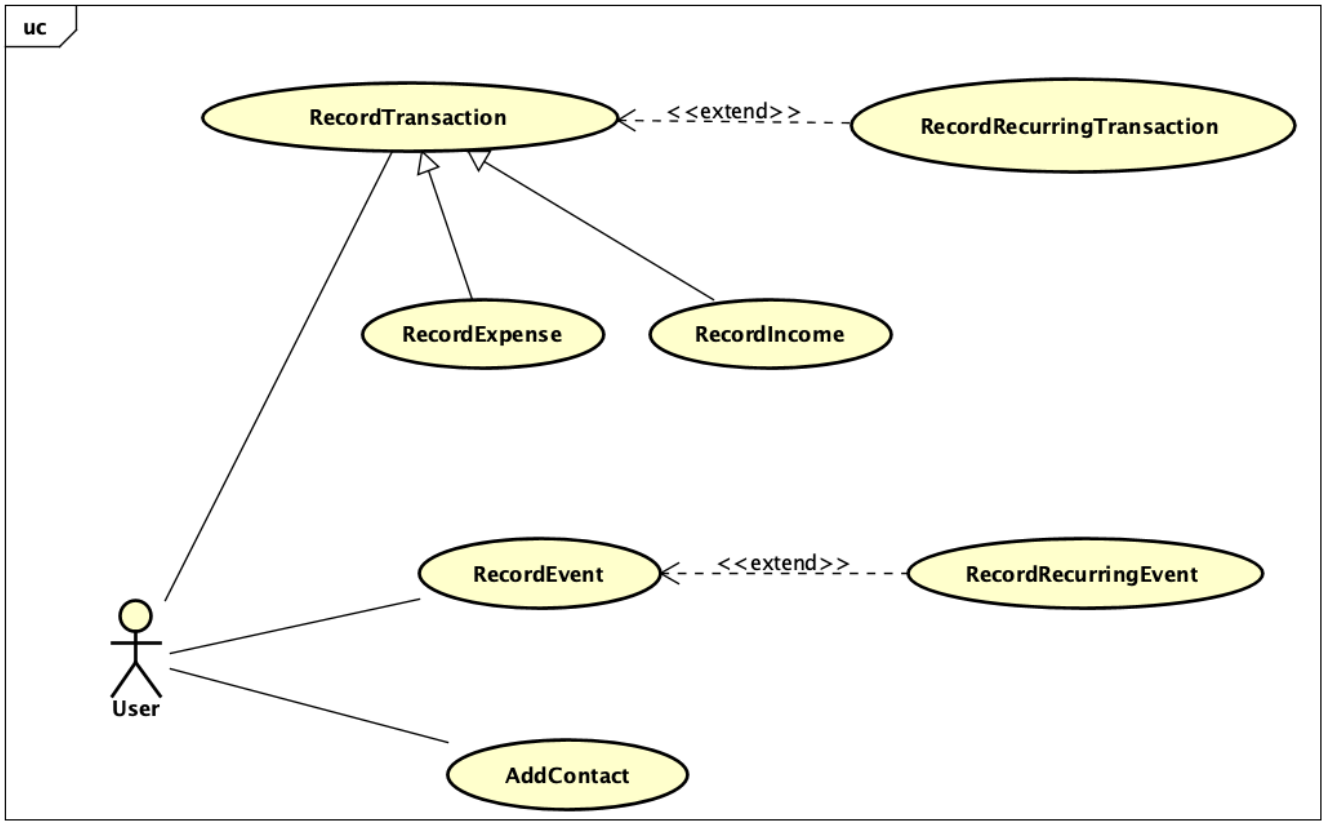


Create Monthly Recurrence Event

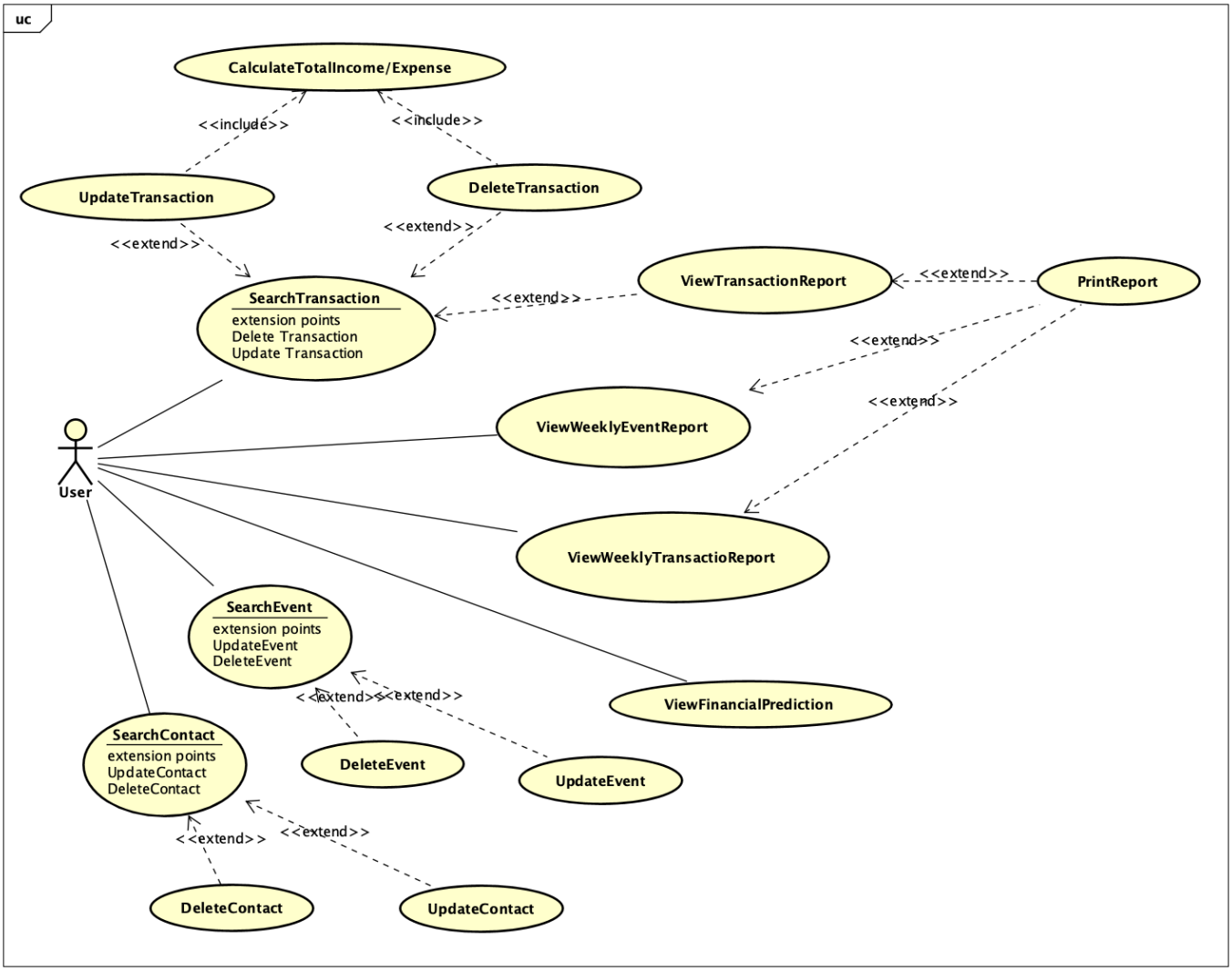


Part B – (1) Use Case Diagram

Use Case Diagram for Add Operations



Use Case Diagram for Manage Operations (View/Update/Delete)



Part B – (2) Use Case Diagram Description

Use case description: Record Transaction

UC No	UC0001	
UC Name	Record Transaction	
UC Description	Recording a new transaction either income or expense. Also, either one-off transaction or recurring transaction. Options are given to the user in order to select 'Transaction Type' and 'Occurrence'. Both income and expense will be recorded as transaction either as one-off transaction or recurring transaction based on the options which user selected.	
UC Priority	High	
Primary Actor	User	
Pre-condition	User with valid authentication status.	
Success End Condition	New transaction should be recorded.	
Triggering Event	User click on 'New Transaction' menu item of the menu bar of main form.	
Main Scenario	**User**	**System**
		1. Open the 'New Transaction' form with default options. Type = 'Income' Occurrence = 'One-off'
	2. Provide a name or a title for the transaction, Specify a date, Specify valid amount	
	3. User can change transaction type to 'Expense' if use want. By default, this is set to 'Income'	
	4. Click on 'save' button	
		5. Validate user inputs
		6. Persist transaction in the database
		7. Acknowledge user with success status
Variation 1		
		(1). Main Scenario Step 1
	(2) Main Scenario Step 2,3	
	(3). Select 'Recurrence' as occurrence type	

		(4). Shows up ‘Frequency’ drop down with ‘Daily’ default value.
	(5). Click on ‘save’ button with default frequency which is daily	
		(6). Main Scenario Step 5, 6, 7
Variation 2		
		(1). Main Scenario Step 1
	(2). Main Scenario Step 2,3	
	(3). Select ‘Recurrence’ as occurrence type	
		(4). Shows up ‘Frequency’ drop down with ‘Daily’ default value.
	(5) Change the ‘Frequency’ to ‘Weekly’	
		(6) Shows up a new form element to specify the day of the week.
	(7). Click on ‘save’ button	
		Main Scenario Step 5,6,7
Variation 3		
		(1) Main Scenario Step1
	(2). Main Scenario Step 2,3	
	(3). Select ‘Recurrence’ as occurrence type	
		4). Shows up ‘Frequency’ drop down with ‘Daily’ default value.
	(5) Change the ‘Frequency’ to ‘Monthly’	
		(6) Shows up a new form element to specify the day of the month.
	(7) Click on ‘save’ button	
		(8).Main Scenario Step 5,6,7
Variation 4		
		(1) Main Scenario Step 1
	(2). Main Scenario Step 2,3 Variation 1 Step (6)	
	(3). Select ‘Recurrence’ as occurrence type	
		4). Shows up ‘Frequency’ drop down with ‘Daily’ default value.
	(5) Change the ‘Frequency’ to ‘Yearly’	
		(6) Shows up a new form element to specify the day of the year.
	(7) Click on ‘save’ button	

		(8).Main Scenario Step 5,6,7
Alternative Scenario 1		At 3, System was unable to find the book for a given keyword. The keyword might be wrong. Go to 3 with different keyword.
Alternative Scenario 2		At 3, System was unable to find the book. The book is not available in the current stock. Then <<extends>> Create Customer Order
Exceptional Scenario 1	A network or server failure. User should be notified with error message.	
Inclusions		
Extensions	Create Customer Order ????	

Use case description: Record Event

UC No	UC0002	
UC Name	Record Event	
UC Description	Recording a new event either as one-off or recurrence. Also, either as tasks or appointments. Based on the occurrence option selected by the user, the event will be either one-off or recurrence. Both one-off and recurrent events can be created from a single form under a single use case.	
UC Priority	High	
Primary Actor	User	
Pre-condition	User with valid authentication status.	
Success End Condition	New event should be recorded.	
Triggering Event	User click on 'New Event' menu item of the menu bar of main form.	
Main Scenario	**User**	**System**
		1. Open the 'Event' form with default options. Type = 'Task' Occurrence = 'One-off'
	2. Provide a name or a title for the event, Start Date, Start Time and End Time and also the Type as 'task' or 'appointment'	
	3. Click on 'save' button	
		4. Validate user inputs
		5. Validate overlapping event
		6. Persist event in the database

		7. Acknowledge user with success status
Variation 1	Create daily recurrence event	
		(1). Main Scenario Step 1
	(2). Main Scenario Step 2	
	(3). Change the 'Occurrence' option to 'Daily'	
		(4). Shows up 'Expire Date' field with on year ahead default value.
	(5). Change 'Expire Date' if needed	
	(6). Click on 'save' button	
		(7). Main Scenario Step 4, 5, 6,7
Variation 2	Create weekly recurrence event	
		(1). Main Scenario Step 1
	(2). Main Scenario Step 2	
	(3). Change the 'Occurrence' option to 'Weekly'	
		(4). Shows up 'Day of Week' drop down with 'Sunday' default value. Shows up 'Expire Date' field with on year ahead default value.
	(5) Specify the 'Day of Week' Change the 'Expire Date' if needed.	
	(6). Click on 'save' button	
		(7) Main Scenario Step 4, 5, 6,7
Variation 3	Create monthly recurrence event	
		(1) Main Scenario Step1
	(2). Main Scenario Step 2	
	(3). Change the 'Occurrence' option to 'Monthly'	
		(4). Shows up input fields to specify the day of the month. Shows up 'Expire Date' field with on year ahead default value.
	(5) Specify the 'Day of Month' Change the 'Expire Date' if needed.	
	(6). Click on 'save' button	
		(7) Main Scenario Step 4, 5, 6,7
Variation 4	Create yearly recurrence event	
		(1) Main Scenario Step 1

	(2). Main Scenario Step 2	
	(3). Change the 'Occurrence' option to 'Yearly'	
		(4). Shows up input fields to specify the month of the year and the day of the month. Shows up 'Expire Date' field with on year ahead default value.
	(5) Specify the month of the year and the day of the month. Change the 'Expire Date' if needed.	
	(6). Click on 'save' button	
		(7) Main Scenario Step 4, 5, 6,7
Alternative Scenario 1		
Alternative Scenario 2		
Exceptional Scenario 1	A network or server failure. User should be notified with error message.	
Inclusions		
Extensions	RecordRecurringEvent	

Use case description: Update Event

UC No	UC0003	
UC Name	Update Event	
UC Description	User should be able to update a selected event. Most of the steps for this use case are almost similar to UC0001 which is 'Record Event' use case.	
UC Priority	High	
Primary Actor	User	
Pre-condition	User with valid authentication status.	
Success End Condition	An existing event should be updated.	
Triggering Event	User performs a search and click on 'Edit' on top of a selected record.	
Main Scenario	**User**	**System**
	(1). <<Include>> Search Event	
	(2). Select event and click 'Edit' button.	
		(3). Opens 'Event' form with pre-populated data from the selected record.

	(4). Change the data as required by the user	
	(5). Click on 'save' button	
		(6) Main Scenario Step 4, 5, 6,7
Variation 1	Update daily recurrence event	
		Steps are same as 'Record Event'
Variation 2	Update weekly recurrence event	
		Steps are same as 'Record Event'
Variation 3	Update monthly recurrence event	
		Steps are same as 'Record Event'
Variation 4	Update yearly recurrence event	
		Steps are same as 'Record Event'
Exceptional Scenario 1	A network or server failure. User should be notified with error message.	
Inclusions	Search Event	
Extensions		

Use case description: Delete Event

UC No	UC0004	
UC Name	Delete Event	
UC Description	User should be able to delete a selected event.	
UC Priority	Low	
Primary Actor	User	
Pre-condition	User with valid authentication status.	
Success End Condition	Event will be deleted from the system.	
Triggering Event	User performs a search and click on 'Delete' on top of a selected record.	
Main Scenario	**User**	**System**
	(1). <<Include>> Search Event	
	(2). Select event and click 'Delete' button.	
		(3). System will ask for confirmation with 'Ok', 'Cancel' button.
	(4). User selects 'Ok' button.	
		(5). Delete the record from the DB or mark the record as inactive.
		(6). Acknowledge the user with success message.
Variation 1	**Abort event delete operation**	
	(1). Main scenario step 1,2	

		(2). Main scenario step 3
	(3). User selects 'Cancel' button	
		(4). Close the confirmation window.
Alternative Scenario 1		
Alternative Scenario 2		
Exceptional Scenario 1	A network or server failure. User should be notified with error message.	
Inclusions	Search Event	
Extensions		

Use case description: Search Event

UC No	UC0005	
UC Name	Search Event	
UC Description	Search events by specifying different search criteria like date or date range, event type, event occurrent etc.	
UC Priority	High	
Primary Actor	User	
Pre-condition	User with valid authentication status.	
Success End Condition	List of matching events for the selected search criteria. If no matching events, empty result.	
Triggering Event	User click on 'Manage Event' menu item of the menu bar of main form.	
Main Scenario	**User**	**System**
	(1). User click on 'Manage Event' menu item from the menu bar.	
		(2). Open 'Manage Event' screen with search form and a grid with data against the default search criteria.
	(3). Specify the search criteria	
	(4). Click on 'Search' button	
		(5). List up all matching events for the defined criteria.
Exceptional Scenario 1	A network or server failure. User should be notified with error message.	
Inclusions		
Extensions	Update Event, Delete Event	

Use case description: Add Contact

UC No	UC0006	
UC Name	Add Contact	
UC Description	Allows to create a contact with details like name, telephone number, address etc.	
UC Priority	Medium	
Primary Actor	User	
Pre-condition	User with valid authentication status.	
Success End Condition	New contact should be recorded.	
Triggering Event	User click on 'New Contact' menu item of the menu bar of main form.	
Main Scenario	**User**	**System**
		1. Open the 'New Contact' form with default options. Type = 'Payer'
	2. File the form	
	3. Click on 'Save' button	
		4. Validate user inputs
		5. Persist contact in the database
		6. Acknowledge user with success status

Use case description: Update Contact

UC No	UC0007	
UC Name	Update Contact	
UC Description	User should be able to update contact.	
UC Priority	Low	
Primary Actor	User	
Pre-condition	User with valid authentication status.	
Success End Condition	Existing contact should be updated.	
Triggering Event	User click on 'Edit' button after selecting a contact from the grid	
Main Scenario	**User**	**System**
	(1) Include <<Search Contact>>	
	(2) Select contact and click on 'Edit' button	
		3. Open contact form with populated data from selected contact.
	4. Change the data and click on 'save' button	

		5. Validate user inputs
		6. Persist contact data in the database
		7. Acknowledge user with success status
Alternative Scenario 2		At 3, System was unable to find the book. The book is not available in the current stock. Then <<extends>> Create Customer Order
Exceptional Scenario 1	A network or server failure. User should be notified with error message.	
Inclusions	Search Contact	

Use case description: Search Contact

UC No	UC0008	
UC Name	Record Transaction	
UC Description	Use should be able to search contact for a given criteria.	
UC Priority	Low	
Primary Actor	User	
Pre-condition	User with valid authentication status.	
Success End Condition	List of contacts matched to given search criteria.	
Triggering Event	User click on 'Manage Contact' menu item of the menu bar of main form.	
Main Scenario	**User**	**System**
	(1). Specify search criteria	
	(2). Click on 'search' button	
		(3). Displays list of contacts matching to specified search criteria.
Exceptional Scenario 1	A network or server failure. User should be notified with error message.	
Extensions	Delete Contact, Update Contact	

Part C: (1) Classes or CRC tables

CRC Table for Event

Class Name	Type	Responsibility	Collaboration
Event	Model	Entity class to map EVENT database table	EventInstance
EventInstance	Model	Representation of specific, unique and static event on a particular day. One to one matching with Event for one-off event and many-to-one mapping with Event for recurrence events.	Event
AddEditEventForm	View	View class which contains UI elements to add or update event +save()	EventController
SearchEventForm	View	View class which contains a search form and a data grid +search() +delete() +initUpdate() +export() +print()	EventController
ViewWeeklyEventForm	View	View class which displays weekly events +print() +export() +previousWeek() +nextWeek()	EventController
EventController	Controller	Controller class which handles requests coming from the view and also responses coming from the model. +add() +update() +delete() +searchEventByCriteria() +getEventById() +fetchWeeklyEvent()	AddEditEventForm SearchEventForm ViewWeeklyEventForm EventService
EventService	Model	Class which contains all business logic related to events +add()	Event EventInstance EventDAO

		+update() +delete() +searchEventByCriteria() +getEventById() +fetchWeeklyEvent()	
EventDAO	Model	Class which access the data base +add() +update() +delete() +searchEventByCriteria() +getEventById() +fetchWeeklyEvent()	DBAccessManager
DBAccessManager	Model	A class which executes all database CRUD operations for the entire application +executeQuery() +executeUpdate()	

CRC Table for Transaction

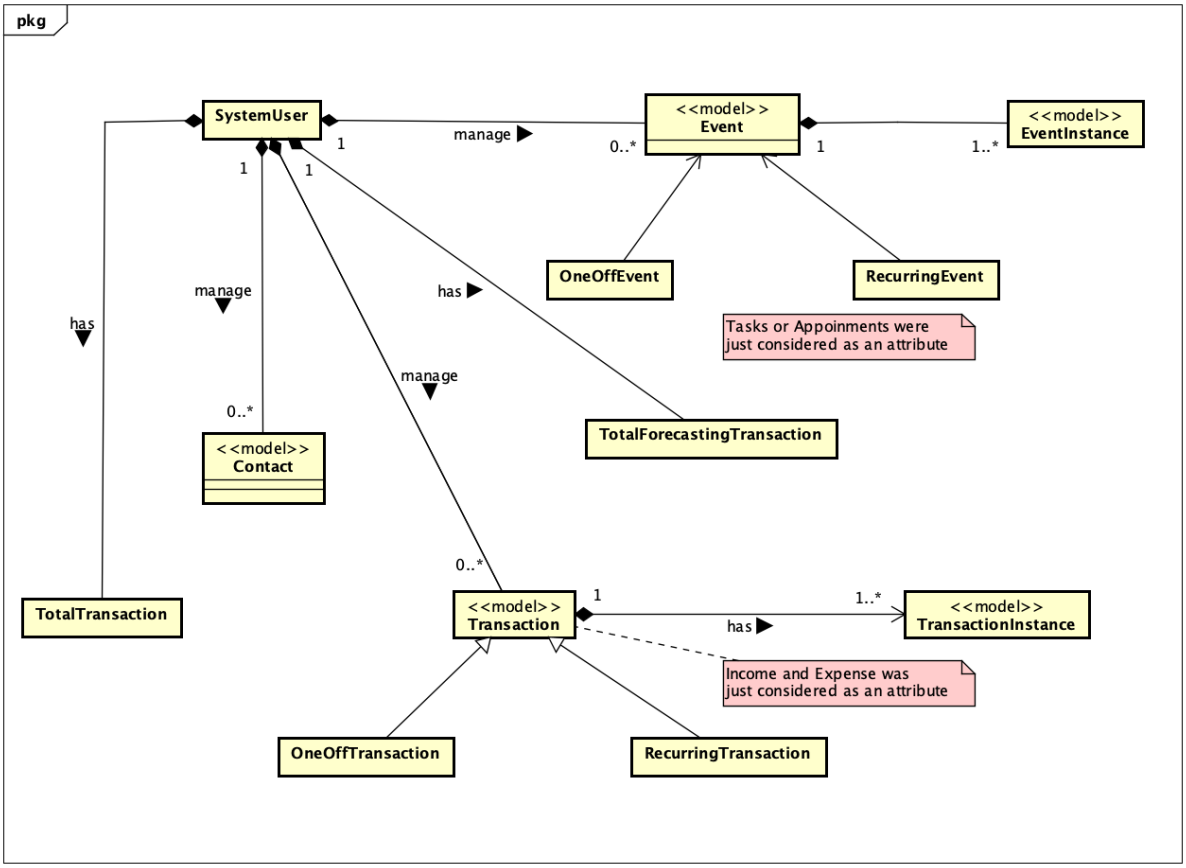
Class Name	Type	Responsibility	Collaboration
Transaction	Model	Entity class to map TRANSACTION database table	TransactionInstance
TransactionInstance	Model	Representation of specific, unique and static transaction on a particular day. One to one matching with 'Transaction' for one-off transaction and many-to-one mapping with 'Transaction' for recurrence transactions.	Transaction
AddEditTransactionForm	View	View class which contains UI elements to add or update transaction +save()	TransactionController
SearchTransactionForm	View	View class which contains a search form and a data grid +search() +delete() +initUpdate() +export() +print() +viewForecast()	TransactionController

ViewWeeklyTransactionForm	View	C# form which displays weekly transactions +print() +export() +previousWeek() +nextWeek()	TransactionController
TransactionController	Controller	Controller class which handles requests coming from the view and also responses coming from the model. +add() +update() +delete() +searchTransactionByCriteria() +getTransactionById() +fetchWeeklyTransaction() +getForecastedData()	AddEditTransactionForm SearchTransactionForm ViewWeeklyTransactionForm TransactionService
TransactionService	Model	Class which contains all business logic related to transactions +add() +update() +delete() +searchTransactionByCriteria() +getTransactionById() +fetchWeeklyTransaction() +getForecastedData()	Transaction TransactionInstance TransactionDAO
TransactionDAO	Model	Database access operations +add() +update() +delete() +searchTransactionByCriteria() +getTransactionById() +fetchWeeklyTransaction() +getForecastedData()	DBAccessManager
DBAccessManager	Model	Execute CRUD operations specific to the DBMS +executeQuery() +executeUpdate()	
ForecastedValueJob	Model	Calculating and updating forecasted values for future dates. This is a back-end Job which runs end of the day. +calculateForecastedValue()	

CRC Table for Contact

Class Name	Type	Responsibility	Collaboration
Contact	Model	Entity class to map CONTACT database table	
AddEditContactForm	View	View class which contains UI elements to add or update contact +save()	ContactController
SearchContactForm	View	View class which contains a search form and a data grid +search() +delete() +initUpdate() +export() +print()	ContactController
ContactController	Controller	Controller class which handles requests coming from the view and also responses coming from the model. +add() +update() +delete() +searchContactByCriteria() +getContactById()	AddEditContactForm SearchContactForm ViewWeeklyContactForm ContactService
ContactService	Model	Class which contains all business logic related to transactions +add() +update() +delete() +searchContactByCriteria() +getContactById()	Contact ContactDAO
ContactDAO	Model	Database access operations +add() +update() +delete() +searchContactByCriteria() +getContactById()	DBAccessManager
DBAccessManager	Model	Execute CRUD operations specific to the DBMS +executeQuery() +executeUpdate()	

Part C: (2) Domain Model



When considering the nature of a transaction, whether it is income or expense, it can be considered as an attribute of a transaction. Because, this particular attribute itself does not make a significant impact for the design of the system which is for class diagram or database table or the implementation of the functionality.

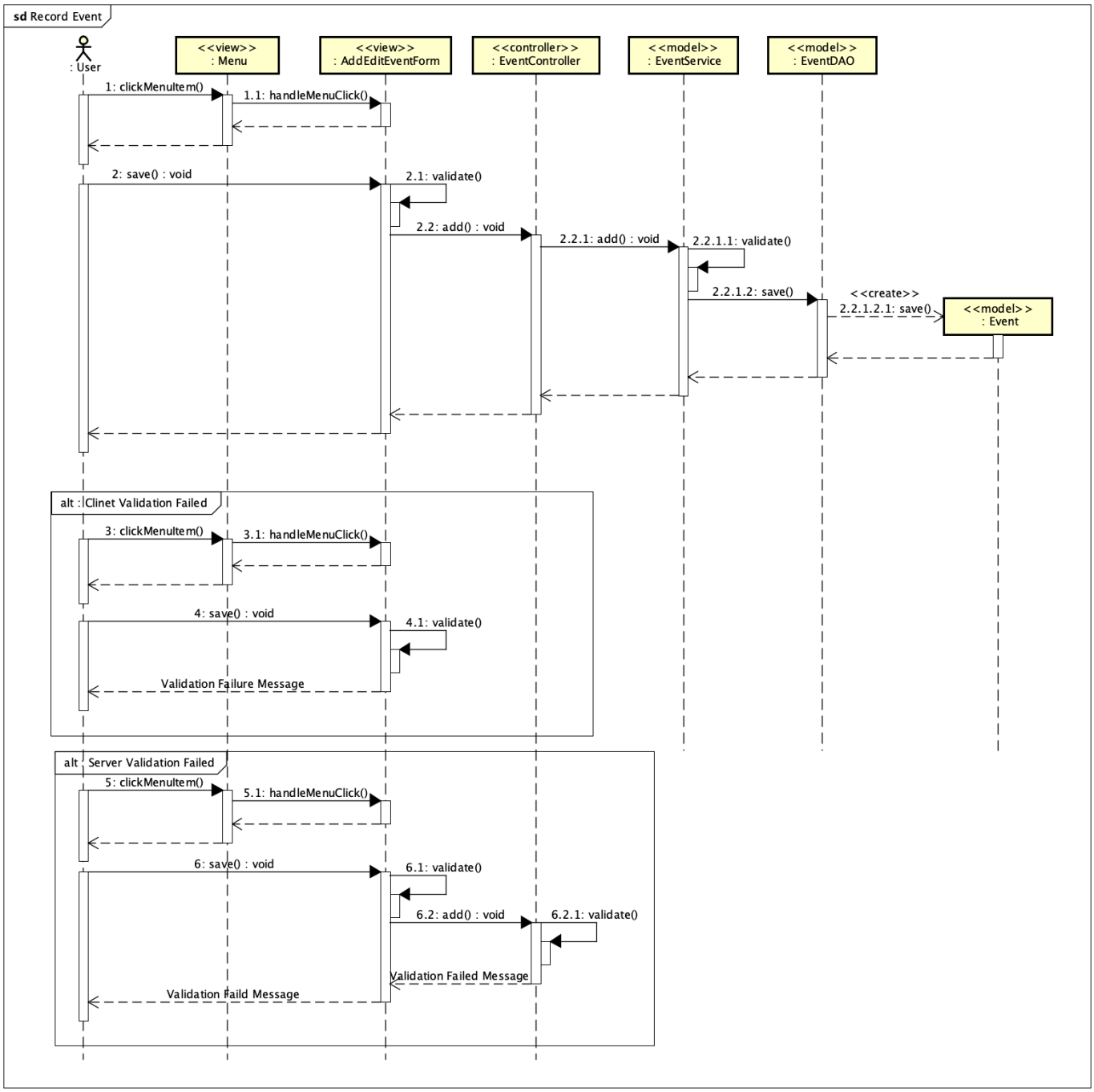
The occurrence type is a key attribute which significantly impact for the design of the system in many of the aspects, like classes, database tables and the implementation.

Also, when it comes to the event, similarly, task or appointment can be considered as an attribute of the event entity. But again, the event occurrence is a key attribute when designing the application.

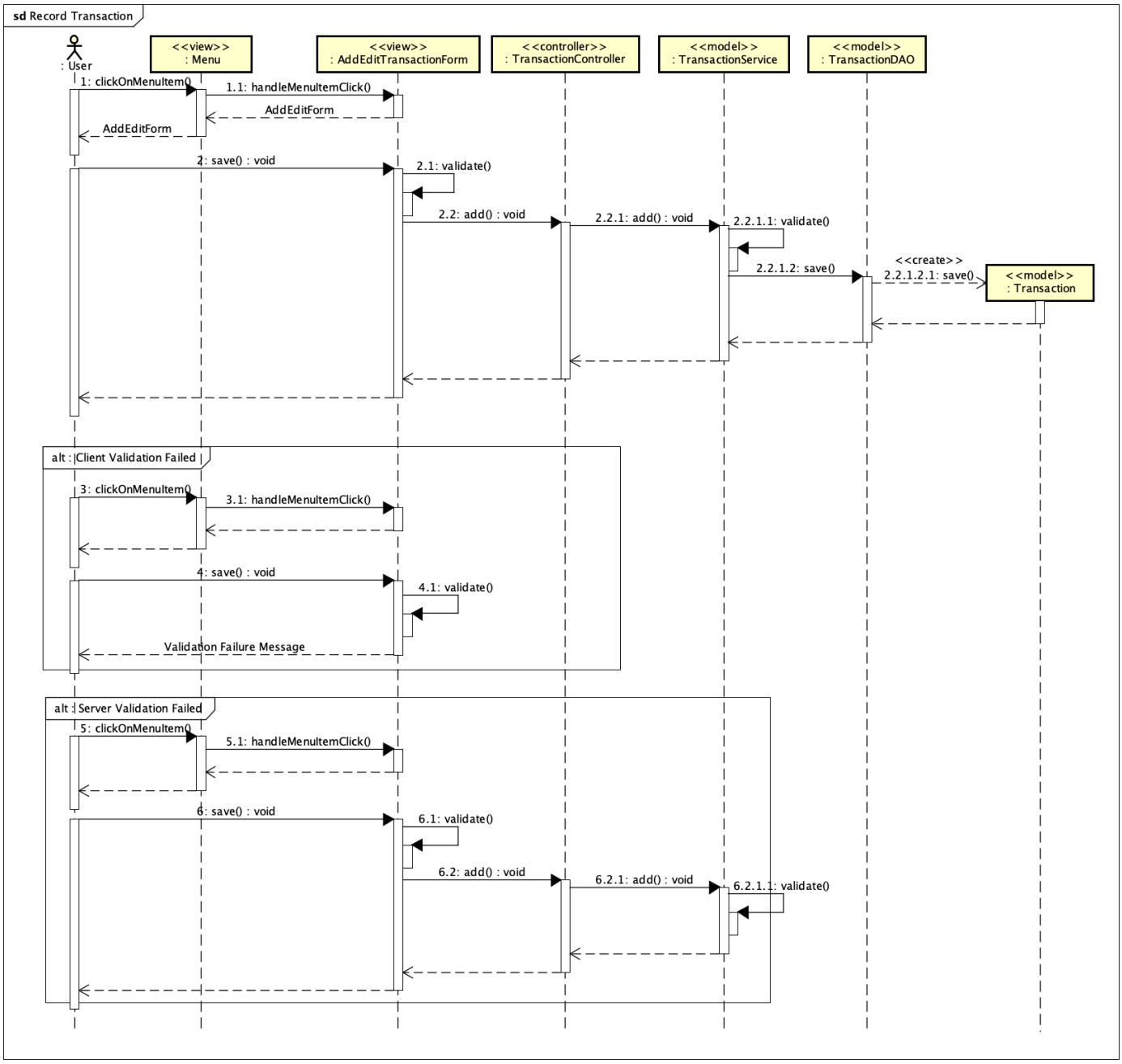
Please see the “Design Decision” section in order to understand ‘EventInstance’ and ‘TransactionInstance’.

Part D: Collaboration

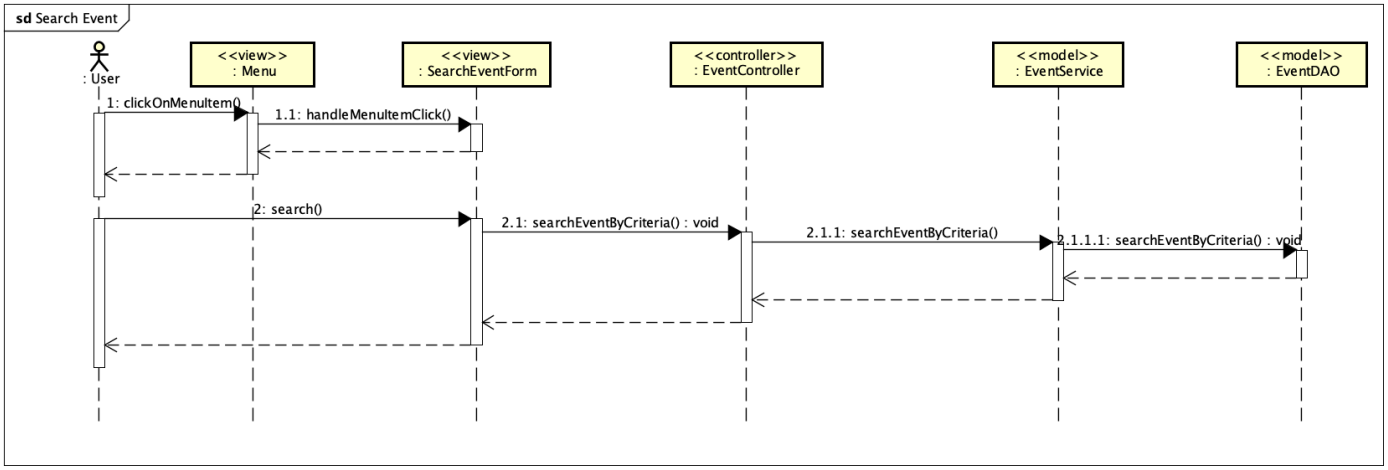
Sequence Diagram – Record Event



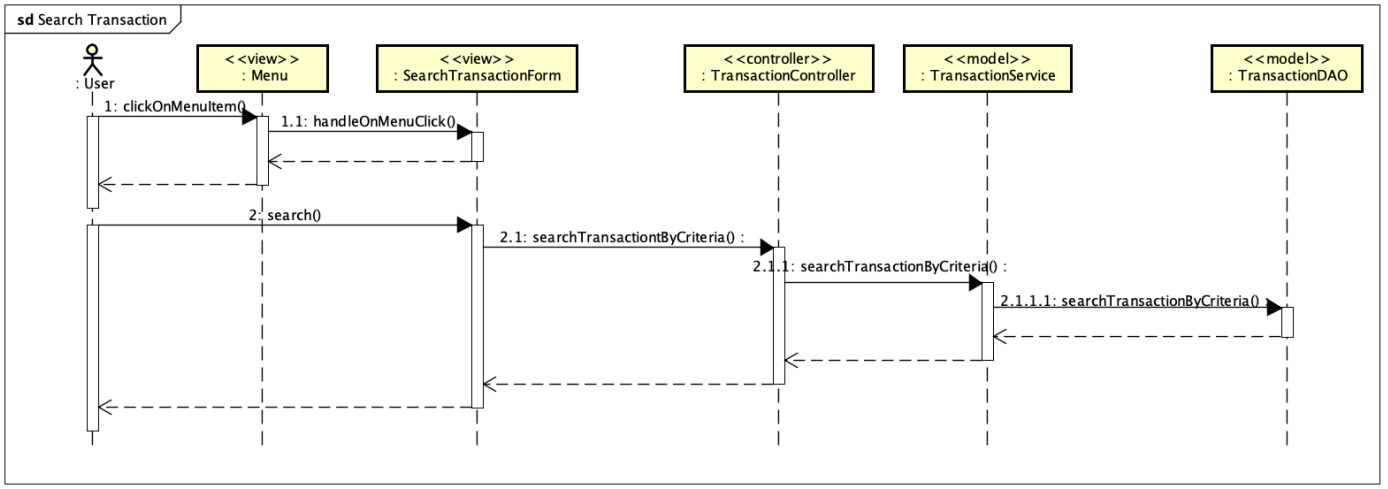
Sequence Diagram – Record Transaction



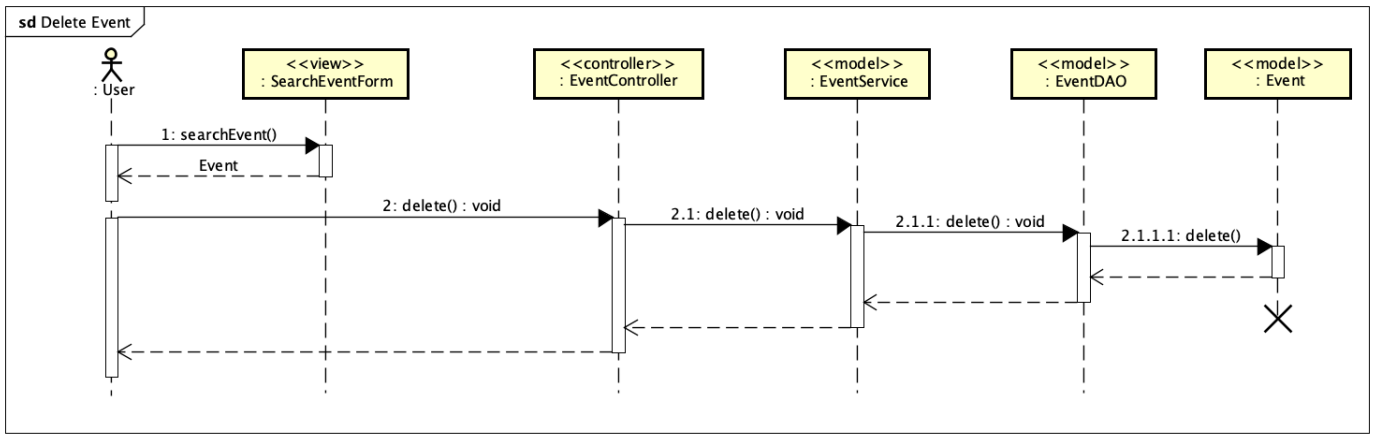
Sequence Diagram – Search Event



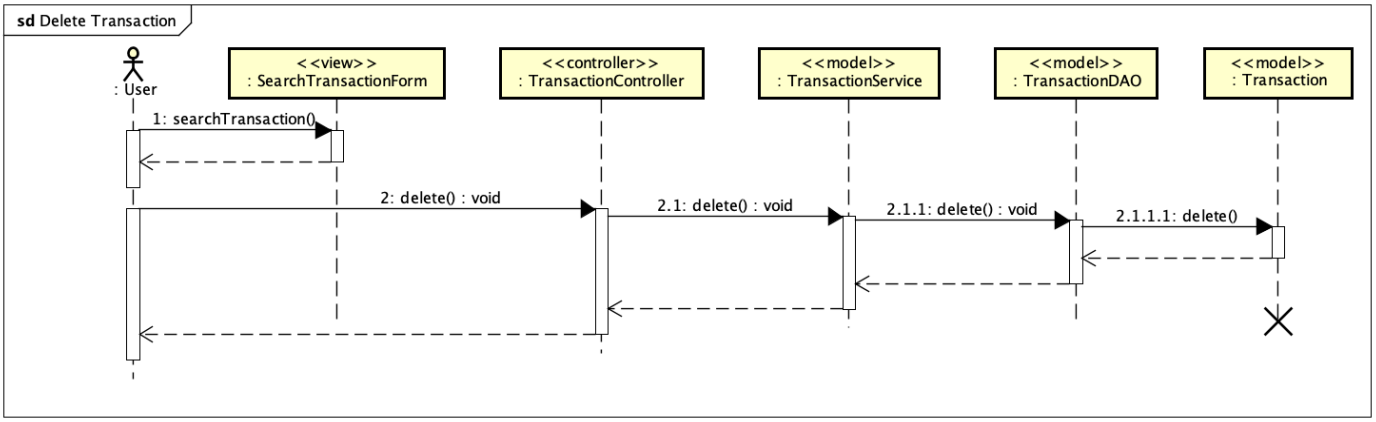
Sequence Diagram – Search Transaction



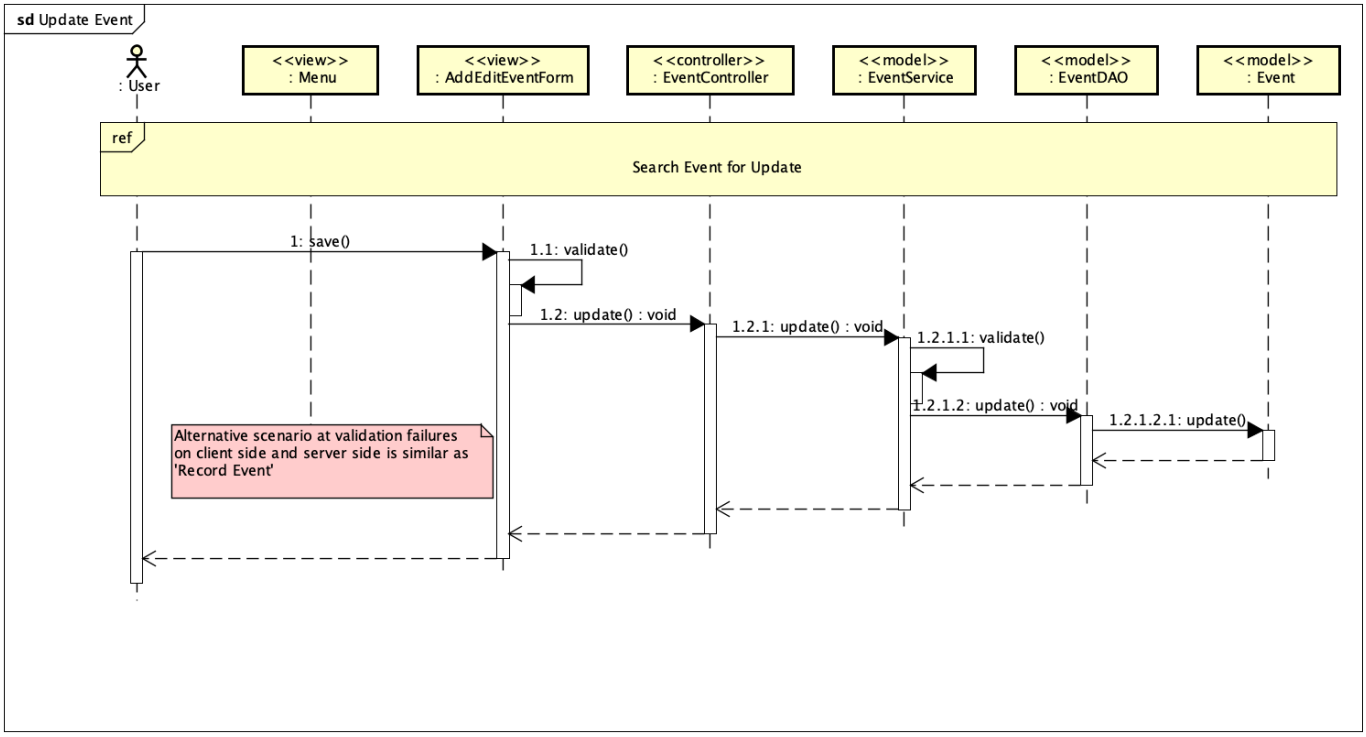
Sequence Diagram – Delete Event



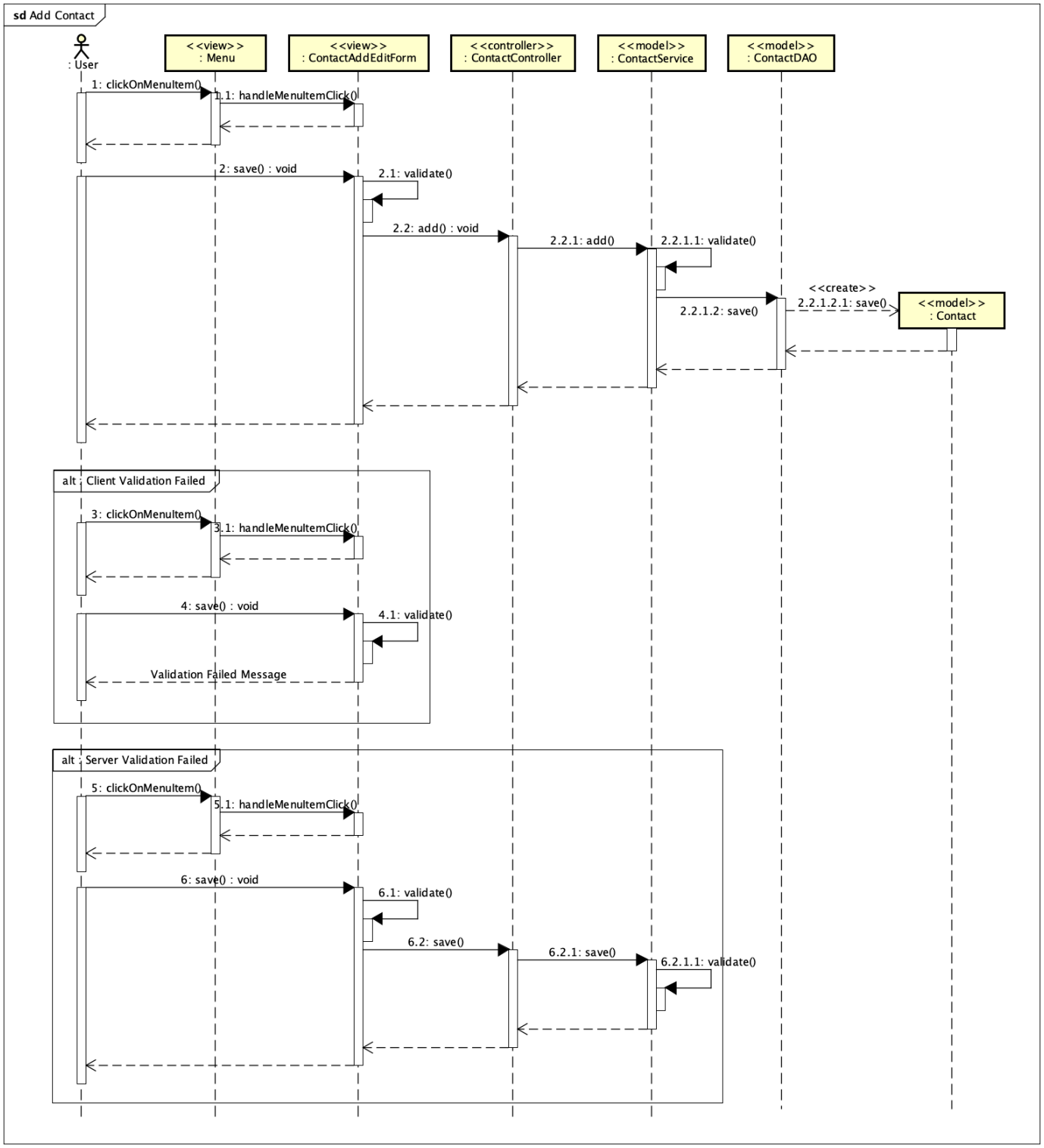
Sequence Diagram – Delete Transaction



Sequence Diagram – Update Event



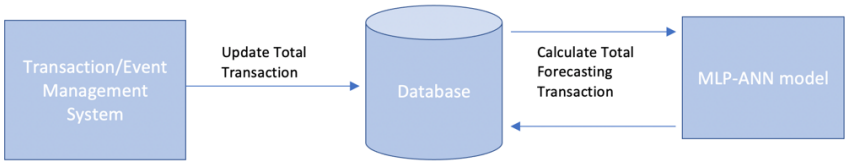
Use case diagram – Add Contact



Part E – Activity One of the following will be used for the implementation

Option 01- MLP- ANN

Multi-layer Perceptron is a class of Artificial Neural Network (MLP-ANN) which is used to forecast the values for future dates by using historical time series set of data. The system will integrate with an MLP-ANN sub module which calculates forecasting transaction values for incomes and expenses for future. The MLP-ANN model will run daily basis and calculate values for next 365 days. The model is developed using R which get the total transaction data from TRANSACTION_TOTAL table and calculated values are saved in FORECASTING_TOTAL table.

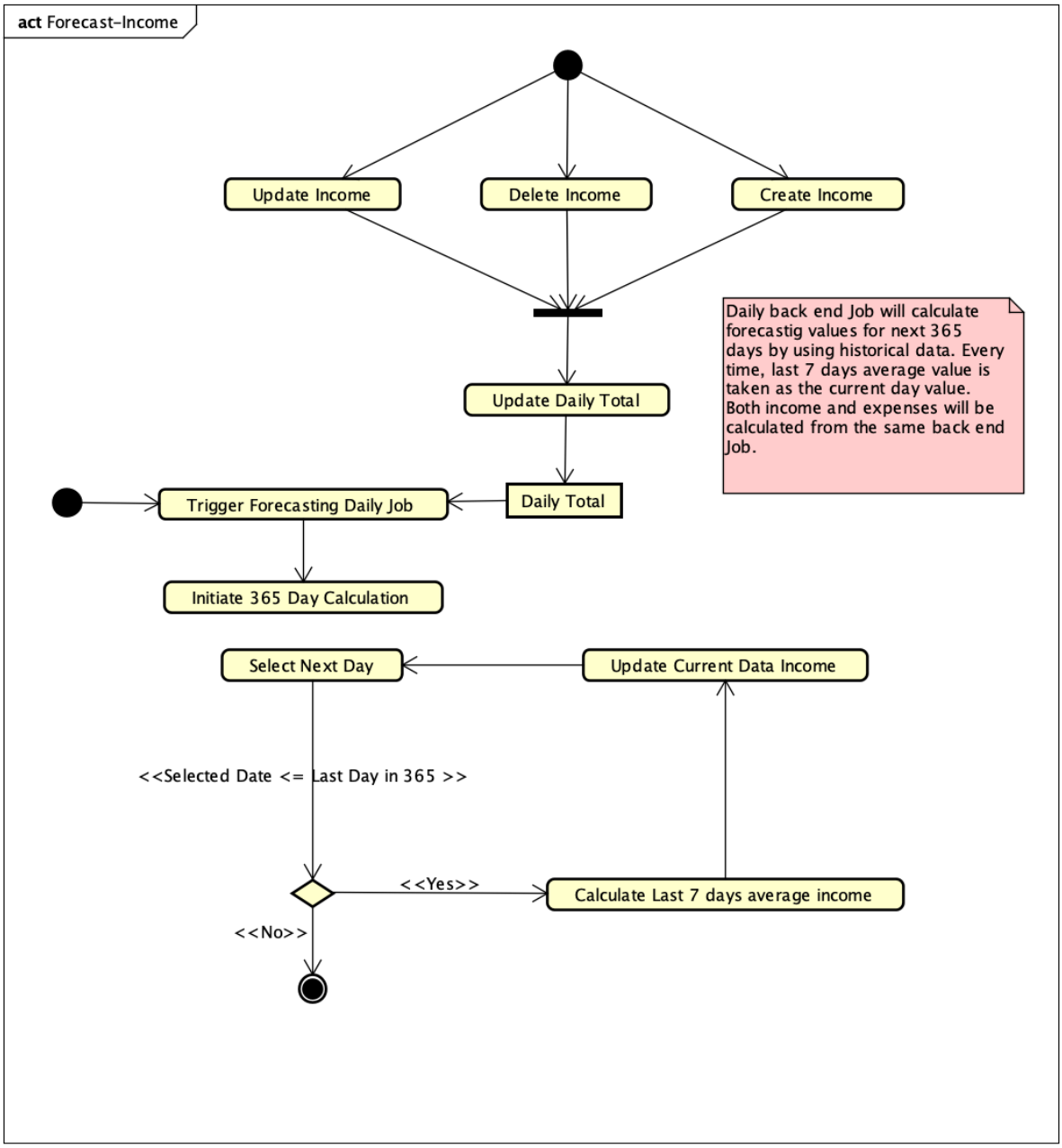


Option 02- Moving Average

Moving average is one of the mechanisms which is used to calculate future values based on historical time series set of data. This technique simply takes the average of the data set within a defined range from previous data set.

In this implementation, average of last 7 days is taken as the forecasted value for the current date. These values are pre-calculated using a back end daily Job for next 365 days. Since, these are pre-calculated values, data fetch operations will be faster than calculating this value on the fly. The following orange color values are forecasted values. Only last 3 days average has been considered for the following example scenario.

DATE	TOTAL INCOME	NEXT_DAY_FORECASTING
2021-03-01	2300	
2021-03-02	3000	
2021-03-03	5000	
2021-03-04	2650	3433.333333
2021-03-05	4500	3550
2021-03-06	4250	4050
2021-03-07	3600	3800
2021-03-08	2750	4116.666667
2021-03-09	3125	3533.333333
2021-03-10	3900	3158.333333
2021-03-11	5100	3258.333333
2021-03-12		4041.666667
2021-03-13		4500
2021-03-14		5100



Part F – Report

(1) Design Decisions

(i) Database table structure is created in the same way for both one-off transaction and recurring transaction. For both type of transactions, there is a header record which is saved in the TRANSACTION table and the details are saved in TRANSACTION_INSTANCE table. One record in the TRANSACTION_INSTANCE represents a unique transaction for unique day. For one-off transaction, there is one to one relationship from TRANSACTION to TRANSACTION_INSTANCE table. For recurring transactions, there is one to many relationships from TRANSACTION to TRANSACTION_INSTANCE table. Two model classes are created to map these two tables.

The following sample table structure will explain this further.

TRANSACTION						
ID	NAME	OCURRENCE	EFFECTIVE_FROM_DATE	EFFECTIVE_TO_DATE	DAILY	WEEKLY
1	One off expense	ONE_OFF	2/14/21	2/14/21		
2	Recurring daily expense	RECURRENCE	3/1/21	3/5/21		
3	Recurring weekly expense	RECURRENCE	3/1/21	12/31/21		
4	Recurring monthly expese	RECURRENCE	3/1/21	12/31/21		
5	Recurring yearly expese	RECURRENCE	3/1/21	12/31/21		

TRANSACTION_INSTACNE		
ID	EVENT_DATE	1
1	2/14/21	2
2	3/1/21	2
3	3/2/21	2
4	3/3/21	2
5	3/3/21	2
6	3/3/21	2
7	..	2

As you can see in above table, transaction with id 1 is one of transaction. It has one mapping record in TRANSACTION_INSTANCE table. Transaction with id 2 is recurring transaction. It has related 5 records in TRANSACTION_INSTANCE.

Similar database design is applied for events as well. It also has a table as EVENT and EVENT_INSTANCE.

(ii) TRANSACTION _INSTANCE and EVENT_INSTANCE tables are populated with in a separate thread which is initiated on the event of transaction create, update or delete. This will improve the performance of data fetch operations and also report view and generation, because this minimizes on the fly data process and complex queries.

(iii) Updating daily total transactions are also calculated within another thread which is initiated on the event of transaction create, update or delete. Both the total daily income and expenses are saved in a table called TRANSACTION_TOTAL as follows. This will improve the performance when displaying the total transaction on the screen, since the total values are pre-calculated. System needs only to fetch total values from the database without doing complex calculations and performing complex queries with the data fetch.

TRANSACTION_TOTAL			
ID	DATE	TOTAL_INCOME	TOTAL_EXPENSE
1	3/12/21	5600	450
2	3/13/21	1000	1450
3	3/14/21		
4	3/15/21		
5	3/16/21		

(iv) Tasks or Appointments are considered as attribute of Events, since this attribute itself does not make significant difference.

(v) As explain above, data model for recurring and one-off has been designed in similar way. This reduces the complexity of the design significantly and improve the performance.

(vi) Calculating total transaction values will be done in asynchronous way within separate threads. Those will not be calculated within the request thread of updating transaction. This will improve the performance when viewing summary or reports etc. In order to achieve this, an event should be triggered from the back end of the application in order to update statistical summary data like total expenses or income for a day. We can use event driven messaging mechanism or simply threaded programs.

(vii) 'Income' or 'Expense' was considered as simple attribute of a particular transaction. This does not make significant difference for transaction. If we consider attributes which we want to save along with recording an income or an expense, most of the attributes are common. We can consider this 'Income' and 'Expense' as a simple attribute of a transaction. When it comes to the occurrence, either 'one-off' or 'recurrence', it significantly deviates the nature of the transaction, UI design, the data that should be stored in the database.

(2) <u>Why this design is more suitable?</u>

(i) Most of the calculations are done in an asynchronous manner which will improve the response time of create/update operations.
(ii) Data view and report operations will be fast because the required calculations are not being done on the fly with the user request. Those are pre-calculated from separate threads.
(iii) Keeping consistence database table structure for both one-off and recurring transactions and events, will reduce the complexity of the development.
(iv) Forecasting values are pre-calculated. This will improve the performance of the forecasting view operations.